# Percutaneous Cryoablation of Metastatic Renal Cell Carcinoma for Local Tumor Control: Feasibility, Outcomes, and Estimated Cost-effectiveness for Palliation

Hyun J. Bang, MD, Peter J. Littrup, MD, Dylan J. Goodrich, BS, Brandt P. Currier, BS, Hussein D. Aoun, MD, Lance K. Heilbrun, PhD, Ulka Vaishampayan, MD, Barbara Adam, NP, and Allen C. Goodman, PhD

## ABSTRACT

**Purpose:** To assess complications, local tumor recurrences, overall survival (OS), and estimates of cost-effectiveness for multisite cryoablation (MCA) of oligometastatic renal cell carcinoma (RCC).

**Materials and Methods:** A total of 60 computed tomography- and/or ultrasound-guided percutaneous MCA procedures were performed on 72 tumors in 27 patients (three women and 24 men). Average patient age was 63 years. Tumor location was grouped according to common metastatic sites. Established surgical selection criteria graded patient status. Median OS was determined by Kaplan–Meier method and defined life-years gained (LYGs). Estimates of MCA costs per LYG were compared with established values for systemic therapies.

**Results:** Total number of tumors and cryoablation procedures for each anatomic site are as follows: nephrectomy bed, 11 and 11; adrenal gland, nine and eight; paraaortic, seven and six; lung, 14 and 13; bone, 13 and 13; superficial, 12 and nine; intraperitoneal, five and three; and liver, one and one. A mean of 2.2 procedures per patient were performed, with a median clinical follow-up of 16 months. Major complication and local recurrence rates were 2% (one of 60) and 3% (two of 72), respectively. No patients were graded as having good surgical risk, but median OS was 2.69 years, with an estimated 5-year survival rate of 27%. Cryoablation remained cost-effective with or without the presence of systemic therapies according to historical cost comparisons, with an adjunctive cost-effectiveness ratio of $28,312–$59,554 per LYG.

**Conclusions:** MCA was associated with very low morbidity and local tumor recurrence rates for all anatomic sites, with apparent increased OS. Even as an adjunct to systemic therapies, MCA appeared cost-effective for palliation of oligometastatic RCC.

## ABBREVIATIONS

ACER = adjunctive cost-effectiveness ratio, BSC = best supportive care, IFN = interferon, LYG = life-year gained, MCA = multisite cryoablation, mRCC = metastatic renal cell carcinoma, OS = overall survival, RCC = renal cell carcinoma, RF = radiofrequency

Renal cell carcinoma (RCC) was diagnosed in an estimated 58,240 new patients in the United States in 2010 (1). Approximately 25%–30% of patients diagnosed with local RCC have overt metastases at presentation, and 33% of patients with RCC at diagnosis develop metastatic disease; this suggests that the development of metastatic RCC (mRCC) is a possibility in more than 50% of all patients with RCC, or approximately 30,000 per year in the United States (2). Treatment responses of mRCC to conventional strategies of chemotherapy, radiation therapy, and hormone therapy have produced a median overall survival (OS) of 7–11 months and a 5-year OS rate of 10% (2). The associated high costs of emerging chemotherapy

From the Departments of Radiology (H.J.B.) and Economics (A.C.G.), Wayne State University; Department of Radiology (P.J.L., B.P.C., D.J.G., H.D.A., B.A.), Department of Biostatistics (L.K.H.), and Division of Hematology and Oncology (U.V.), Karmanos Cancer Institute, 1026 Harper Professional Building, 4100 John R, Detroit, MI 48201. Received December 14, 2011; final revision received February 29, 2012; accepted March 2, 2012. Address correspondence to P.J.L.; E-mail: littrupp@karmanos.org

This study was partially supported by National Institutes of Health Cancer Center Support Grant CA-22453. None of the authors have identified a conflict of interest.



*J Vasc Interv Radiol 2012; 23:770–777*

http://dx.doi.org/10.1016/j.jvir.2012.03.002

**Table 1.** Patient, Procedure, and Tumor Characteristics

| Characteristic | Soft Tissue | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nephrectomy Bed | Adrenal Gland | Paraaortic | Superficial | Intraperitoneal | Bone | Subtotal | Liver | Lung | Total |
| No. of patients | 7 | 5 | 5 | 5 | 3 | 7 | 32* | 1 | 6 | 37* |
| No. of procedures | 11 | 8 | 6 | 9 | 3 | 13 | 50† | 1 | 13 | 64† |
| No. of tumors | 11 | 9 | 7 | 12 | 5 | 13 | 57 | 1 | 14 | 72 |
| Mean tumor diameter ($cm^3$) | 4.8 | 2.9 | 2.8 | 3.1 | 2.6 | 4.8 | 3.7 | 2 | 1.6 | 3.3 |
| Mean ablation diameter ($cm^3$) | 6.4 | 4.5 | 4.6 | 5.0 | 4.7 | 6.8 | 5.5 | 4 | 3.3 | 5.1 |
| Mean no. of probes | 4.9 | 4.5 | 4.2 | 3 | 2.5 | 4.4 | 3.8 | 3 | 2.6 | 3.6 |

Note.—Lung tumor locations consisted of metastatic lesions in lung parenchyma and did not include mediastinal or hilar adenopathy. Retroperitoneal tumors included local recurrences following nephrectomy, metastatic adrenal masses, as well as any paraaortic/pericaval mass or adenopathy. Superficial tumor locations consisted of predominantly subcutaneous, muscular, and/or lymph node metastases within the extremities or torso wall. Intraperitoneal tumors were isolated within the abdominal cavity and not adherent to bowel. Tumors in bone locations were limited metastatic deposits in non–weight-bearing locations with the epicenter in osseous structures.

* Ten patients had tumors in multiple areas, which overlapped in the final patient count. Actual patient count is 27.

† Two patients had two procedures each in two areas, accounting for four extra procedures. Actual procedure count is 60.

regimens have therefore required cost-effectiveness evaluations to justify minor survival benefits (3–8). It is also uncertain which patients benefit enough from systemic treatments to then be considered for local treatments of limited metastatic, or oligometastatic, RCC.

Metastasectomy, or the resection of oligometastatic RCC, is a surgical option primarily for pulmonary involvement, providing 5-year survival rates as high as 50% (9,10). Pulmonary metastasectomy has been considered cost-effective for soft-tissue sarcoma when considering only costs and no quality-of-life adjustments (11). However, a recent report on 1,463 patients with newly diagnosed RCC noted that only 21% underwent pulmonary metastasectomy, despite 62% presenting with mRCC at initial diagnosis (12). Therefore, a large unmet need exists for expanding the survival benefits of metastasectomy to the broadest possible group of patients with mRCC.

Reductions in morbidity and treatment cost, while still improving survival rates, are important for the adoption of minimally invasive treatments (13). Computed tomography (CT)-guided percutaneous cryoablation has been shown to be a well tolerated and effective treatment for primary RCC (14,15); however, studies have yet to explore its effectiveness in treating mRCC. The visible treatment zone of cryoablation, lower pain, and minimal morbidity allowed us to apply our established cryoablation techniques (15–18) to many anatomic sites for local control of limited mRCC.

The purpose of this study was to assess the potential role of multisite cryoablation (MCA) of oligometastatic RCC by evaluating complications, local recurrences, survival, and projected procedure costs in relation to systemic treatments. Estimates of MCA cost-effectiveness were compared versus best supportive care (BSC) and emerging chemoimmunotherapy regimens (3–8) to place an economic perspective on our outcomes for this select group of patients.

## MATERIALS AND METHODS

### Patients

Consecutive patients with mRCC scheduled to undergo cryoablation read and signed an authorization form issued under the Health and Insurance Portability and Accountability Act of 1996. All patients also signed a separate consent form detailing the procedure, as well as an investigational review board approved consent form for prospective collection of procedure, imaging, and clinical parameters. Included in the study were 27 consecutive patients with mRCC (24 male, three female) with an average age of 63 years (range, 19–86 y). The eight procedural locations included lung (n = 13), liver (n = 1), and six soft-tissue sites: nephrectomy bed (n = 11), adrenal gland (n = 8), paraaortic (n = 6), superficial (n = 9), intraperitoneal location (n = 3), and bone (n = 13; **Table 1**).

Inclusion criteria for cryoablation consisted of a localized soft tissue mass smaller than 7 cm that was biopsy-proven or deemed suspicious based on a CT image showing an enhancing, growing mass or positive findings on positron emission tomography. Patients should not have more than five cancerous foci in an organ site to avoid compromising safety in patients with advanced disease and to allow MCA to treat all metastases present at the time of the first procedure over the course of one or multiple procedures. These patients were generally referred by oncologists or surgeons for local control of oligometastatic RCC. Tumors in multiple locations were treated in single or multiple