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Original article

Long-term oncologic outcomes following radiofrequency ablation with real-time temperature monitoring for T1a renal cell cancer

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Abstract

Objective: Few studies report long-term follow-up of renal cancer treated by radiofrequency ablation (RFA), thus limiting the comparison of this modality to well-established long-term follow-up series of surgically resected renal masses.

Herein, we report long-term oncologic outcomes of renal cancer treated with RFA in a single institution.

Methods and materials: We retrospectively reviewed patients treated between November 2001 and October 2012 with laparoscopic-guided or computed tomography–guided RFA. All treatments were performed with real-time thermometry ensuring target ablation temperature ($>60^{\circ}C$) was adequately reached. Only patients with biopsy-confirmed T1a-category cancer and a follow-up period >48 months were included in our analysis. Follow-up included office visits, laboratory work, and periodic contrast-enhanced imaging.

Survival was calculated using the Kaplan-Meier analysis. Overall complications were reported using the Clavien-Dindo scale.

Results: Of 434 RFA cases, 53 treatments in 50 patients met the inclusion criteria. Of these, 29 were treated with computed tomography–guided RFA and 24 with laparoscopic-guided RFA. The mean follow-up interval was 65.6 months (48.5–120.2), and the mean renal mass size was 2.3 cm (0.3–4.0). There were 4 (7.5%) local recurrences and 1 case of distant metastases with no local recurrence. The 5-year overall survival was 98%, cancer-specific survival was 100%, and recurrence-free survival was 92.5%. The complication rate was 26.4%, which included 71% of Clavien-Dindo grade I and 29% of grade II. Mean estimated glomerular filtration rate preoperatively and at the most recent follow-up visit was 77 and 66 ml/min, respectively.

Conclusions: When performed on selected patients, while monitoring real-time temperatures to ensure adequate treatment end points, RFA offers favorable long-term oncologic outcomes approaching those reported for partial nephrectomy.

Keywords: Renal cancer; Thermal ablation; Image-guided therapy; Laparoscopy; Malignant disease; Percutaneous renal surgery

1. Introduction

The incidence of kidney cancer has been increasing over the past 3 decades. This has been largely attributed to smoking, obesity, and hypertension [1], as well as to the growing number of incidentally detected renal masses. In 2013, it was estimated that 65,150 new cases of kidney and renal pelvis cancers were diagnosed in the United States, accounting for 13,680 estimated deaths [2]. The median age at diagnosis was 64 years [3], thus a proportion of these patients would potentially be considered high risk for surgical intervention attributed to concomitant comorbidities.

Partial nephrectomy remains the gold standard treatment for small renal masses (SRMs); however, for the subset of older high-risk patients, a minimally invasive ablative technique provides an attractive alternative.

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Thermal ablation for renal masses was first described in 1995 and though several modalities are commercially available, cryoablation and radiofrequency ablation (RFA) are the ones most widely used [4]. Cryoablation results in an ice-ball formation, serving as a radiographic marker for ablation zone size and treatment progression. The ablation zone created by RFA cannot be radiographically monitored during real time, thus most centers performing RFA use a treatment algorithm based on predicted ablation zone size and a predetermined treatment time. We believe that real-time temperature monitoring provides an added level of accuracy and safety, thus all our treatments were performed using fiber-optic temperature sensors placed 5 mm beyond the edge of the target tumor.

Presently, only a small number of studies report long-term oncologic follow-up results for computed tomography (CT)–guided RFA (CTRFA) [5], of which even fewer include outcomes for laparoscopic RFA (LRFA).

In this study, we report long-term oncologic outcomes of biopsy-confirmed renal cancer treated either with CTRFA or with LRFA using real-time temperature monitoring in a single institution.

2. Patients and methods

We reviewed our prospectively collected database of patients with solid enhancing renal masses treated between November 2001 and October 2012 with LRFA or CTRFA. Institutional review board approval for this study was obtained.

The inclusion criteria consisted of patients with a follow-up longer than 48 months who underwent RFA for biopsy-proven renal cell carcinoma (RCC).

For LRFA, a transperitoneal approach was used as previously described [6]. Following medial mobilization of the bowel, the retroperitoneal space was entered and the kidney and tumor(s) was exposed. The tumor was localized with the aid of an intracorporeal ultrasound (US) (Aloka drop-in or laparoscopic transducer). Up to 4 fiber-optic thermosensors (Lumasense, Santa Clara, CA) were placed 5 mm beyond the tumor periphery under US guidance using a coaxial guide needle with a radiopaque sheath (Huey, Cook Vascular, Inc, Vadergrift, PA). Next, 3 or more biopsy cores were obtained using an 18-gauge spring-loaded biopsy needle (Boston Scientific, Natick, MA). In most cases, RFA was delivered via an impedance-based generator using single or multiple 3-cm Cool-tip water-perfused ablation probes (Covidien Inc, Boulder, CO). In approximately 10% of the cases, a temperature-based RFA generator combined with the StarBurst system RITA probe was used (Angiodynamics). The probes were placed into the tumor under direct vision with US guidance and single or multiple deployments were used, depending on tumor size. Treatment progression was assessed by real-time peripheral fiber-optic thermometry to determine treatment end points $>60^{\circ}$C. Ablation was typically completed within a single 12-minute single deployment. In cases where temperatures reached $<60^{\circ}$C additional cycles or deployments, or both, were employed. All treatments were performed by the urologic surgical team.

For percutaneous RFA, the patients underwent general endotracheal anesthesia and were placed in a prone position on the CT scanner table. A CT scan without contrast was used to identify the tumor and place the thermosensors at its periphery, as described earlier. In cases where the mass could not be clearly identified, intravenous contrast was used. An identical protocol to the LRFA was followed for obtaining the tumor biopsy and for delivering the RFA treatment (described earlier). The treatment end point was temperature based and was not determined based on duration or radiographically. These were performed by the urologic surgeon/interventional radiology team working together in the suite.

Follow-up included physical examination, basic metabolic panel measurement, and serial contrast-enhanced cross-sectional imaging (CT or magnetic resonance imaging) at 1 and 6 months, and then annually thereafter. Chest radiography and liver function tests were performed annually. The preoperative and the most recent glomerular filtration rate values were calculated using the Cockroft-Gault estimated creatinine clearance formula.

Residual tumor was defined as persistent enhancement (>20 HU) within the ablated site seen on the 1-month postablation follow-up imaging study.

Tumor recurrence was defined as enhancement (>20 HU) within an ablation site, which was previously read as nonenhancing on the 1-month posttreatment imaging study.

Suspicious enhancements lead to shorter follow-up intervals or to a renal biopsy either before a subsequent intervention or at the time of the intervention.

We used oncologic outcome definitions similar to those used by the American Urological Association (AUA) SRM guideline panel [7]. Recurrence-free survival (RFS) was defined as the proportion of patients without any disease in the ablation zone. Disease-free survival (DFS) was defined as the proportion of patients without any disease, including both the absence of local and metastatic recurrence. Cancer-specific survival (CSS) was defined as the proportion of patients who did not die of RCC whereas overall survival (OS) was defined as the proportion of patients who did not die of any cause.

We reviewed the OS, CSS, RFS, DFS, and the overall complication rate and degree (reported using the Clavien-Dindo grading scale). Survival data were calculated based on data available during the last documented clinical visit or radiographic study.

Using the Social Security Death Index, we verified the alive status of each patient in our cohort (last accessed June 24, 2013).