Percutaneous Microwave Ablation of Renal Tumors Using a Gas-Cooled 2.4-GHz Probe: Technique and Initial Results

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ABSTRACT

The feasibility, safety, and preliminary effectiveness of microwave ablation (MWA) in the treatment of renal tumors using a high-powered, carbon dioxide–cooled probe were evaluated. There were 15 tumors treated in 14 patients. Computed tomography was performed immediately after MWA, and follow-up imaging was performed to evaluate for recurrence. Immediate technical effectiveness was 100%. One complication involved the formation of a renal artery pseudoaneurysm. At follow-up (mean interval, 12.5 wk) evaluation, 14 of 15 (93.3%) tumors demonstrated complete necrosis. MWA is a safe, effective treatment modality; larger studies are warranted to demonstrate long-term oncologic outcomes.

ABBREVIATIONS

CO_2 = carbon dioxide, MWA = microwave ablation, RCC = renal cell carcinoma

The incidence of renal cell carcinoma (RCC) has been steadily increasing in the United States; the estimated number of new cases of cancers of the kidney and renal pelvis was 64,770 in 2012 (1). Traditionally, the "gold standard" of treatment for any nonmetastatic enhancing renal mass was radical nephrectomy; however, over the past 2 decades there has been a shift toward nephron-sparing techniques, including partial nephrectomy and thermal ablation for localized (T1) disease. This approach allows for cancer treatment while decreasing the risk of progression to chronic kidney disease. At the present time, the recommendation by the American Urological Association for management of a T1 renal mass is for partial nephrectomy, with either radical nephrectomy or thermal ablation considered appropriate alternative options (2), particularly in patients at high risk for progression to chronic kidney disease.

Ablative techniques have the advantage of being able to be performed percutaneously, allowing discharge on the same day of the procedure and less operative time, without the inherent risks of open or laparoscopic surgery. Both cryoablation and radiofrequency (RF) ablation have been extensively studied for the treatment of localized RCC (3–6). Microwave ablation (MWA) is another ablative modality that has been demonstrated to be safe and efficacious in the treatment of small hepatocellular carcinomas (7). The investigation of its use in the treatment of RCC has been limited, but preliminary experiences have demonstrated high technical and clinical success (8–14). Numerous theoretical benefits of MWA over RF ablation have been well described (15) and include higher intratumoral temperatures and better conductivity in tissues with high impedance. Several studies have previously demonstrated larger ablation zones with MWA compared with RF ablation (16–18). Because the kidney is a highly vascular organ, the success of RF ablation can be limited secondary to

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heat-sink effects (19). MWA does not have this disadvantage because of a much larger zone of active heating rather than a reliance on thermal conduction as in RF ablation (20). By the same mechanism, MWA is not as restricted by tissue charring and desiccation, which is a major limiting factor in RF ablation.

A major limitation of MWA that has been described is overheating of the antenna shaft, which can limit power delivery (21). To overcome this disadvantage, many MWA devices have been manufactured using water to cool the antenna, and several water-cooled MWA systems are available on the market. This development has been at the cost of larger antenna diameter (22). A newer MWA system using a gas-cooled mechanism allows the delivery of high power in a small-diameter 17-gauge antenna. The purpose of this study was to evaluate the feasibility, safety, and preliminary effectiveness of this high-powered, gas-cooled MWA system for percutaneous treatment of enhancing renal parenchymal tumors.

MATERIALS AND METHODS

This retrospective study was performed following approval by an institutional review board. From December 2011 to May 2013, 15 renal tumors in 14 consecutive patients referred to our service with localized T1a RCC underwent MWA with curative intent using a percutaneous MWA system. Inclusion criteria included solid enhancing renal mass (attenuation increase > 15 Hounsfield units on postcontrast computed tomography [CT] images or visible enhancement on subtracted magnetic resonance [MR] postcontrast images), T1a lesions (maximum lesion diameter of 4.0 cm and no evidence of vascular invasion), and no evidence of extrarenal metastasis. The decision was made to perform percutaneous ablation over partial nephrectomy or traditional nephrectomy if at least one of the following indications existed: high risk of progression to chronic kidney disease (n = 4), history of prior RCC with prior nephrectomy (n = 2), or significant comorbidities causing high surgical risk (n = 8). Exclusion criteria included tumors > 4.0 cm, imaging evidence of vascular invasion, evidence of extrarenal metastases, and patients with a short life expectancy (< 6 mo).

There were 15 renal tumors treated in 14 patients (10 men and 4 women with a mean age of 62 y). All tumors demonstrated enhancement on CT (Fig 1a) or MR imaging performed before the procedure. Tumor and patient

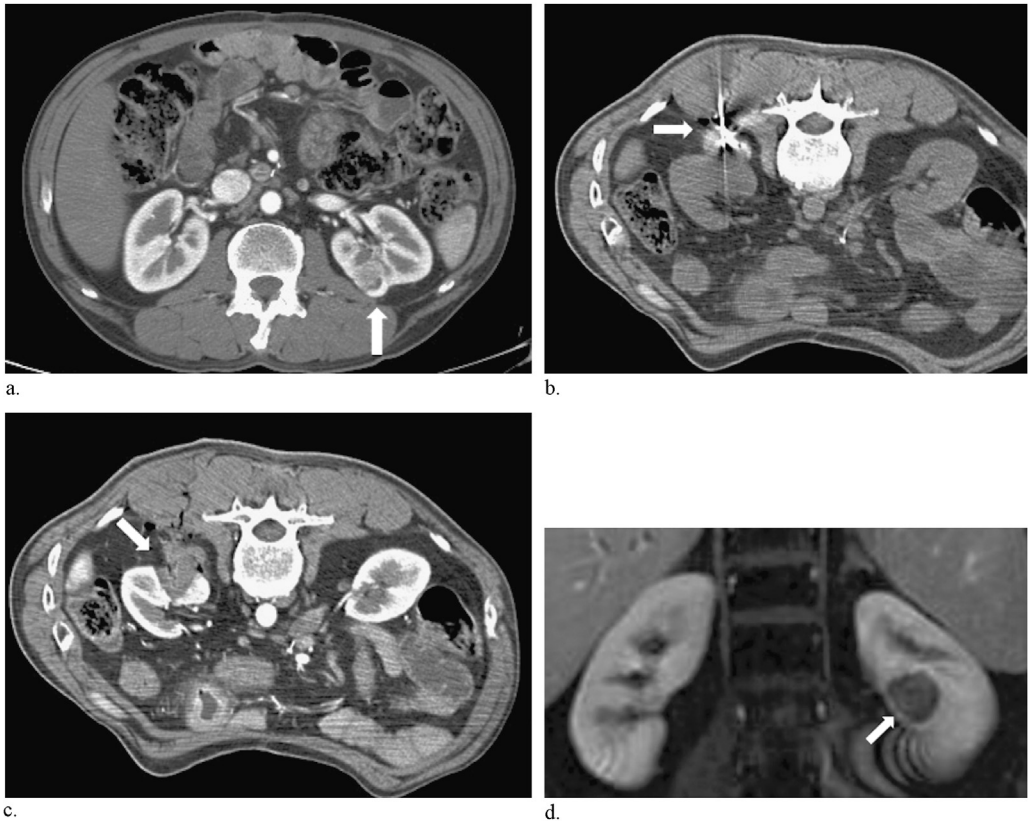

Figure 1. **(a)** Contrast-enhanced CT image obtained before the procedure demonstrates a heterogeneously enhancing 2.5-cm, primarily intraparenchymal mass in the posterior left kidney (arrow). **(b)** Non–contrast-enhanced CT image obtained during the procedure demonstrates a single MWA PR15 probe (NeuWave Medical) with its tip in the renal mass (arrow). Ablation was performed for this case at 65 W for 5 minutes. **(c)** Contrast-enhanced CT image obtained immediately after ablation demonstrates no residual enhancement of the mass, with surrounding air and inflammatory changes secondary to the procedure (arrow). **(d)** Contrast-enhanced coronal MR image obtained at 16 weeks after the procedure demonstrates complete tumor necrosis (arrow). A biopsy specimen demonstrated grade 2 clear cell RCC.