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ORIGINAL ARTICLE

Radiofrequency ablation of renal tumors in patients unfit for surgery. Our experience

I. Gkialas[1], M. Kontraros,[1] P. Vassilakis[1], S. Spanopoulos[1], E. Theodoropoulos[2], G. Stathouros[1], D. Moshonas, K. Doumas[1]

[1]Department of Urology and [2]Department of Radiology, General Hospital of Athens "G. Gennimatas", Athens, Greece

Summary

Purpose: *To evaluate the feasibility and safety of the minimally invasive percutaneous technique radiofrequency ablation (RFA) in patients with small renal cell carcinomas (RCCs) who are unfit for surgery.*

Methods: *From January 2008 to November 2009, 7 patients (5 males and 2 females, median age 78 years) with small RCCs were treated with RFA. The indications for RFA were either inoperability due to high cardiovascular and pulmonary risk or a high probability of complete renal failure after nephrectomy. Exclusion criteria were tumor size larger than 6 cm and the localization of the tumor within the renal pelvis.*

Results: *All RFAs were technically successful in terms of complete tumor ablation and all procedures could be done under conscious sedation. Complications after RFA included transient rise in plasma creatinine in 2 patients and hydrocalyx at 18 months in one. The mean hospital stay was 3.14 days (range 2-5).*

Conclusion: *RFA has limitations such as an uncertain long-term oncological result and need for strict follow up. Physicians must be aware of these limitations and present them clearly to the patients. It is a safe treatment modality that, with longer follow-up, could play a more important role in the care of patients with renal masses due to its potential for decreased morbidity, shorter convalescence, and the ability to avert the higher risk of extirpative surgery in an aging patient population.*

Key words: minimal invasive techniques, radiofrequency ablation, renal cell carcinoma, transarterial embolization

Introduction

The widespread use of cross-sectional body imaging in recent years has lead to a significant increase in the incidence of RCC. Most incidentally diagnosed renal masses are small, and the majority (65-80%) of these tumors are RCCs [1]. Patients presenting with these lesions are counselled on all available treatment options, including active surveillance, radical nephrectomy, nephron sparing surgery, and needle-ablative techniques. In the past, radical nephrectomy was routinely offered for small renal masses. It is now increasingly clear that a nephron-sparing approach should be preferred when feasible [2,3]. However, extirpative surgery is not without shortcomings, since open partial nephrectomy is often performed through a large flank incision, is associated with prolonged convalescence, and can cause complications in up to 30% of cases [4,5]. In addition to nephron-sparing nephrectomy, percutaneous tumor ablation therapies (cryoablation, RFA, laser-induced thermal ablation-LITT), primarily developed for liver malignancies, have been investigated in the treatment of primary and secondary RCC [6-9]. In those studies, complete thermal ablation was shown to depend on tumor size (<3-4 cm), tumor geometry (no components in the renal sinus fat), and tumor vascularity [10]. With current high-power radiofrequency generators, complete ablation can be achieved in 95% of the cases, although a second session may be required to achieve complete necrosis, especially in larger or central tumors [11,12]. Renal RFA can be performed laparoscopically or percutaneously. RFA has been approved by the US Food and Drug Association for hyperthermic ablation of soft tissue tumors. Its successful use

Correspondence to: Ioannis K. Gkialas, MD, FEBU. 12 Prigkiponisson street, 171 22 Athens, Greece. E-mail: igkialas@ath.forthnet.gr
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has been widely published for neoplasms arising in the liver, bone, lung, breast, and kidney [13,14].

The aim of the present study was to evaluate the feasibility and safety of minimally invasive percutaneous techniques, like RFA, in patients with small RCCs who were unfit for surgery.

Methods

From January 2008 to November 2009, 7 patients aged 78 years (median) with small RCCs were treated with percutaneous RFA. The indications for RFA were either inoperability due to high cardiovascular and pulmonary risk or a high probability of complete renal failure after surgical enucleation of the tumor. Exclusion criteria were tumor size larger than 6 cm and localization of the tumor within the renal pelvis. Five patients were males and 2 females. Prior to each therapy a CT or MRI was obtained to assess size and exact location of the tumor and to rule out extrarenal tumor spread. In all 7 patients, a percutaneous renal mass biopsy was performed prior to RFA, and a clear cell RCC phenotype was determined. In all patients the tumor diameter was larger than 3 cm (median 3.9, range 3-5.5). All tumors treated were either exophytic or within the parenchyma of the kidney and no tumor was located within or in close proximity to the renal pelvis.

In 3 cases the tumor diameter was over 4 cm and therefore a transarterial embolization (TAE) was performed prior to RFA. Depending on the size and location of the tumor, RFA or superselective TAE followed by RFA were used. Superselective TAE was performed using a 5 Fr Cobra catheter in the main renal artery with superselective embolization via a 3 Fr microcatheter in the tumor feeding artery using polyvinyl alcohol particles (PVA, Contour 150-250 lm and 350-500 lm, Boston Scientific, Natick, MA, USA) (Figure 1).

RFA was performed using CT (Somatom 4, Siemens, Erlangen, Germany) guidance with fluoroscopy and an expandable, multitined electrode (RITA StarBurst FLEX, RITA Medical Systems, Mountain View, CA, USA) (Figure 2). During the ablation procedure patients were intravenously sedated with midazolam and fentanyl citrate. The target temperature in RFA was set at 105° C and the maximum energy delivered was 200 W. The ablation procedure was performed according to the manufacturer's operating recommendations, with consecutive deployment of electrode tips up to the size of the tumor.

The generator modulates power up to 200 W to achieve an average temperature of 105° C, as measured by 5 of the 9 tines in the StarBurst XL probe. Once this target temperature is reached, tumors requiring tine deployment less than 2 cm are ablated for 5 min, tine deployment between 2 and 3 cm for 7 min, and tine deployment beyond 3 cm for 8 min. A 30-sec cool-down period is followed by a second ablation cycle of identical duration. Occasionally, very small lesions (1 cm or less) are treated with a single 3-5-min cycle. Extra cycles are applied at the surgeon's discretion if ablation is considered to be incomplete on visual or radiographic inspection. Safety margins were minimal and electrode tips were usually not advanced beyond visible tumor borders. Track ablation was used in all patients to reduce the risk of postinterventional bleeding or tumor cell seeding.

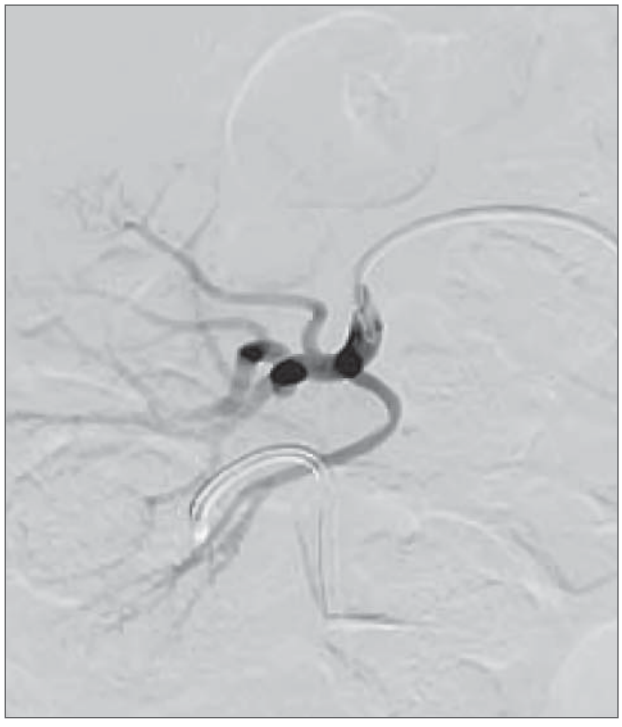

Figure 1. Superselective transarterial tumor embolization with particles and iodized oil using a 3 Fr microcatheter.

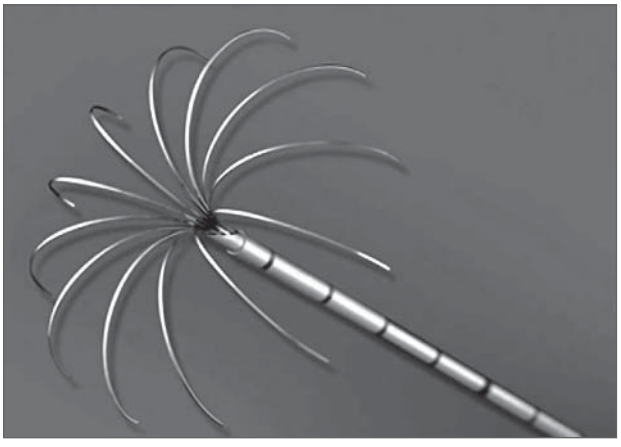

Figure 2. Expandable, multitined electrode (RITA StarBurst FLEX, RITA Medical Systems, Mountain View, CA, USA).

Standard follow-up was performed by contrast-enhanced CT or MRI, depending on renal function and other contraindications. First scheduled follow-up was within 3 days after ablation followed by follow-up imaging at least every 6 months. Postinterventional renal function was measured by serum creatinine and creatinine clearance using the Cockroft-Gault formula: creatinine clearance =[(140 - age) · body mass [kg])/(plasma creatinine [lmol/l] · 0.85) · gender correction factor (female 0.85; male 1.0) [15]. Incomplete ablation was defined as any enhancement within the tumor ablation zone on CT or MRI on initial imaging after RFA. Recurrence was defined as any enhancement within the tumor ablation zone after an initial non-enhancing CT or MRI. Shrinkage of the ablated lesion was not a requirement for ablation success as long as growth and contrast enhancement were absent [16].

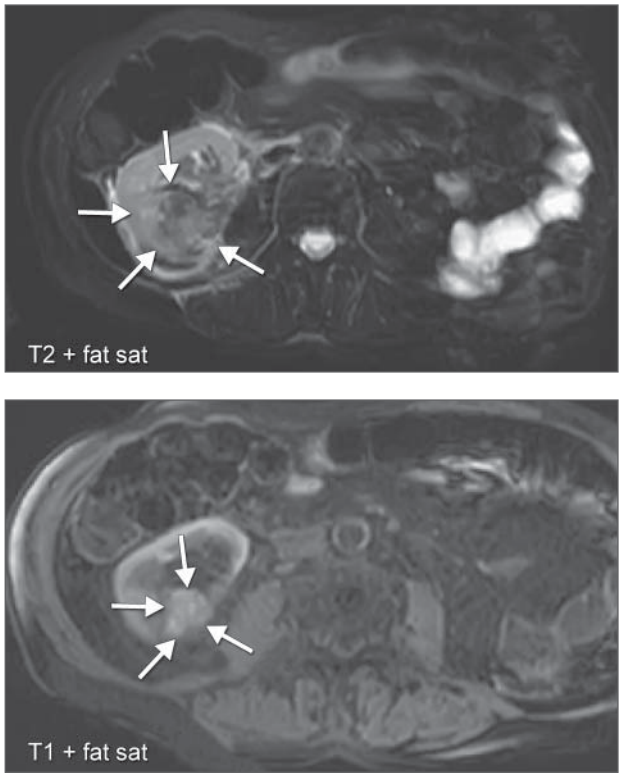

Figure 3. A: MRI before RFA showing the renal tumor (arrows). **B:** Postinterventional control MRI 2 days after RFA, already showing shrinkage of the tumor (arrows).

Results

All RFAs were technically successful in terms of complete tumor ablation and all procedures could be done under conscious sedation (Figure 3). In 3 patients with tumour diameter >4 cm, a preoperative selective tumor embolization was performed. Not one single procedure had to be stopped due to unbearable pain, agitation, missing compliance or prompt-occurring adverse events. In one case, a patient with a renal mass of 5.5 cm, a second procedure was programmed and performed to ensure a safe outcome. In all, 7 masses in 7 patients were treated with RFA. Tables 1 and 2 summarize the patient and disease characteristics. The mean follow-up was 13.5 months (range 6-24). The mean tumor size was 3.9 cm. There was no local tumor recurrence or progression to metastatic disease at the last follow-up, giving a cancer-specific survival rate of 100% (Table 1). Complications after RFA included transient rise in plasma creatinine in 2 patients and hydrocalyx at 18 months in one. The mean hospital stay was 3.14 days (range 2-5; Table 1).

Discussion

Treatment of small RCCs with RFA is a minimally invasive percutaneous technique with promising therapeutic results [6-8]. Depending on tumor size and location, complete necrosis (based on imaging criteria) has been achieved in 79-100% of the cases [17].

The advantage of the multitined electrode probes (Figure 1) is the reduced risk of movement during respiration (the probe is locked in the lesion with an umbrella-like tip). The use of an introduction sheath/coaxial needle can be used for injection (saline, air, CO_2),

Table 1. Characteristics of 7 RCC patients

Characteristics	
Age, years, mean (range)	78.4 (72-85)
Males/females	5/2
Body mass index, kg/m^2, mean (range)	35.8 (27-40)
Hospital stay, days, mean (range)	3.14 (2-5)

Table 2. Tumor characteristics in 7 patients

Characteristics	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Tumor size (cm; median 3.9)	3	3.5	5.5	3.8	4	4.2	3.3
Location	mid	mid	low	upp	low	mid	low
Recurrence	no	no	no	no	no	no	no
Follow-up (months; mean 13.5)	6	8	14	9	24	16	18

to displace critical structures (hollow viscera, pancreas) or to seal the needle track with gelatine foam (e.g., gel foam) or fibrin. An antitumor effect has also been demonstrated by Brok et al., who stated that thermal ablation could create antitumor immunity generated by the large amount of tumor debris remaining *in situ* [18]. Thermal lesion volume is strongly influenced by blood flow, that dissipates energy, thus leading to heat convection estimated with the "bioheat transfer equation" (coagulation necrosis = energy deposited · local tissue interactions - heat loss) [19,20]. The difference in treating RCC - in contrast to liver lesions - is the high blood flow in the kidney (4-fold higher than in the liver), which increases the conductive heat loss during the ablation procedure. Pre-interventional tumor embolization has been shown to reduce heat loss and to result in larger areas of ablation. This provides larger tumor-free margins, possibly leading to a reduction in marginal recurrences, and reduces the necessity of a second ablation. Combined embolotherapy and percutaneous RFA in RCC has been reported by other authors before [21,22]. Analogous to the situation with hypervascularized liver lesions, Yamakado et al. showed that combining embolization and thermal ablation increases the ablation volume and the safety of ablations near critical structures such as the renal pelvis [23]. Percutaneous TAE was introduced into clinical practice in the early 1970s, mainly for palliative or preoperative treatment in RCC [24,25]. The most important risk of embolotherapy is unintentional embolization. Complications following RFA in renal neoplasms are haemorrhage, infection, bowel injury, nerve injury, ureteral strictures, urine leaks, and cutaneous fistulas. In patients with large recurrent tumors or in tumors adjacent to critical structures, one should favor the combined therapy approach with embolization and RFA [26,27].

In our series, 2 patients presented with pain and one with macroscopic haematuria. In all other patients the renal mass was an incidental finding. Four patients were considered poor surgical candidates due to high cardiovascular risk. Three patients refused the surgical extirpation of the mass, and accepted the RFA as an alternative treatment. All patients gave signed informed consent. With a mean follow up of 13.5 months, none of our patients had tumor recurrence, including the patient with the largest (5.5 cm) mass. Postoperatively, no major complication occurred, despite the frailty and the high cardiovascular risk of the patients, and the mean hospital stay was 3.1 days [28-30].

A longer follow-up is expected to determine the long-term outcome in these patients. However, in these difficult clinical cases (symptomatic presentation, old age, severe co-morbidities, unwillingness to undergo surgery) RFA proved to be an effective and safe alternative.

Conclusion

RFA alone or in combination with superselective embolization is a safe and efficient approach in poor surgical candidates and patients unwilling to undergo nephrectomy for small renal tumors. RFA however has limitations, such as an uncertain long-term oncological result and need for a strict follow-up. Physicians must be aware of these limitations and present them clearly to the patients.

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