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4-year experience with percutaneous US-guided radiofrequency ablation of kidney tumors

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Summary

Background: The past decades have significantly changed the diagnosis and management of kidney tumors. There is a growing trend for a less invasive therapeutic approach. The study seeks to present our experience with a number of patients who underwent percutaneous ultrasound (US)-guided radiofrequency ablation (RFA) of renal masses.

Material/Methods: From July 2002 to December 2006, RFA was carried out in 55 selected patients with an enhancing kidney tumor on computed tomography (CT). The procedure was performed under conscious sedation. The patients were at risk for surgery or had a remaining kidney. Monopolar Cool-tip Tyco or bipolar Celon Olympus RFA devices under US-guidance (convex 3.5 MHz) were used. Abdominal 3-phase multi-slice computed tomography (MSCT) was performed 3, 6 and 12 months post RFA and once yearly thereafter.

Results: At a mean follow up of 25 months (range, 6-53 months), 52 of the 55 tumors showed no contrast enhancement on CT. Three incompletely ablated tumors were successfully treated with the second RFA. There were no major complications in any procedure and intervention was well tolerated. So far we have observed one metastasis to a homolateral adrenal gland which was revealed on MSCT.

Conclusions: Percutaneous RFA is a minimally invasive technique which appears to be a promising alternative for patients with small renal tumors. 3-phase MSCT improves the imaging of renal masses, enabling not only optimal treatment planning but also a reliable monitoring of tumor destruction after RFA.

Key words: minimally invasive technique • renal tumor • radiofrequency ablation

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Background

The past decades have changed significantly the diagnosis and management of renal tumors. With the introduction of multi-slice computed tomography (MSCT) and development of magnetic resonance imaging (MRI) (phased-array multicoils, fast breath-hold imaging) in the last few years, more than 50 % of kidney tumors are discovered incidentally and many of them represent an early stage lesion [1]. This gives an increasing need for less invasive treatment options i.e., laparoscopic partial nephrectomy, radiofrequency ablation or cryoablation [2]. Minimally invasive techniques (MIT) have been developed to achieve two aims: to preserve renal function and to lower morbidity. Modern ablative techniques for renal tumors include mainly cryoablation and radiofrequency ablation (RFA). RFA involves inducing the coagulative necrosis of tumor tissue via needle electrodes. RFA is currently performed with the use of open gantry MRI, CT scan or US. At most centers, renal masses are not routinely biopsied before surgical removal because of the risk of tumor seeding and the possibility of a false-negative

pathological result [2]. Therefore, preoperative diagnosis is commonly based on imaging findings only [3]. At present, our indication for RFA of renal tumors is limited only to strictly selected patients who would be at operative or anesthetic risk or who have a remaining kidney. Currently, the use of MIT is being increasingly advocated for the management of small (<4 cm) renal tumors, not only in patients who are unfit for surgery but also who simply prefer to avoid the conventional surgical approach.

Materials and methods

From July 2002 to December 2006, 58 RFA procedures in 55 selected patients with kidney tumors were performed. The average tumor size was 36 mm (range, 18-59 mm) with a mean age of 67 years (range, 28-83 years). 6 patients were over 80 years old. Most of the diagnosed kidney tumor candidates had contraindications to surgery; some of the patients with a remaining kidney did not accept nephrectomy and chronic dialysis. In our group, 15 patients had one kidney only and 2 had cancer recurrence in the remaining kidney after the nephron- sparing surgery (NSS) made several years ago. Kidney tumors were localized out of the renal sinus, frequently in a lower pole near the exterior renal surface (tab. 1). Eligibility for RFA was based on abdominal US and abdominal MSCT generating 16 x 0.5 mm slices with each half-second gantry rotation, the Aquilion Toshiba with workstation Vitrea 2. The patients underwent non-contrast MSCT and contrast-enhanced examinations after the injection of 100 ml of non-ionic contrast medium at a flow rate of 2.5-4.5 ml/s at the arterial and parenchymal phases. The three-dimensional (3D) images were taken using axial scans MPR (Multiplanar Reconstruction), MIP (Maximum Intensity Projection) and VR (Volume Rendering). In every case the contrast enhancement of tumor of more than 20 Hounsfield units (HU) was described in CT. Needle biopsy was made only 3 times, where there was a suspicion of angiomyolipoma. Monopolar Cool-tip Tyco or bipolar Celon Olympus RFA devices under US- guidance (convex 3.5 M Hz) were used. Only 2 procedures were carried out with bipolar RFA. RFA was performed under conscious sedation with local anesthesia and consisted of 1 or 2 punctures of a single straight RFA probe, depending on tumor perimeter. We made a US-guided puncture in an attempt to obtain a 5 to 7 mm safe margin of normal renal parenchyma in order to avoid skip areas and to obtain oncological efficacy. For small lesions < 3 cm, one puncture of an RFA probe was enough to coagulate neoplastic tissue. For lesions > 3 cm before starting ablation we placed 2 straight probes within 1 cm of each other. Afterwards RFA by means of the first and then the second probe was performed. The ablation was stopped after reaching a temperature of 70°C in the center of the lesion and the procedure was finished with tract ablation in order to prevent hemorrhage. The average RFA time was between 10 and 15 minutes, depending on the size of the tumor. This was enough to receive tissue necrosis. The coagulated tumor was left in situ and was not examined histopathologically. All patients received antibiotics for 5 days and a painkiller – paracetamol - where necessary. Treatment efficacy was assessed by MSCT 3, 6 and 12 months post RFA and once yearly thereafter. The absence of contrast enhancement on CT was considered to confirm a successful treatment.

Results

The average follow-up was 25 months (range, 6-53 months) (tab. 1). 52 tumors (94.5%) underwent total tissue necrosis after the only procedure and 3 (5.5%) after the second ablation session – RFA - was repeated in these cases because of incomplete tumor destruction after the initial treatment. 3 lesions which demanded repetition of RFA were > 34 mm, mean size = 47 mm. Lesions < 34 mm showed no enhancement in CT after the only RFA. There were no complications following 51 of the procedures, including every RFA in small (< 3.5 cm) exophytic renal tumors. In 4 interventions complications included (tab. 1): 2 patients with temporary increase in serum creatinine and urea level with up to 38.5°C fever, 1 patient with anuria, hyperkaliemia and uraemia which demanded temporary dialysis and 1 with neuralgy diagnosed later as shingles. There were no hemorrhage or bowel complications in any of the cases. Currently, all the patients are alive and there is no need for a chronic dialysis for any of those cases with the remaining kidney. In the follow-up in 1 patient we observed a metastasis to a homolateral adrenal gland. The gland was removed, the kidney with the coagulated tumor was assessed during the surgical procedure and its tissue was examined histopathologically - no viable cancer cells were detected.

Discussion

Percutaneous radiofrequency ablation (pRFA) has demonstrated encouraging results as a minimally invasive and safe technique for the treatment of small renal tumors [4, 5]. Hospital stay and costs are often reduced because of a quick recovery [6]. RFA can be even performed in an outpatient basis. Moreover, in case of incomplete tumor destruction it may be safely repeated (3 times in our group).

The most common complications include pain and paresthesis. Other complications, such as perinephric haematomas, transient haematuria, ureteropelvic junction obstruction, colon injury, and liver burns, have been described [7, 8, 9]. We had no major complication. In our opinion, a metastasis to a homolateral adrenal gland does not seem to be related to our procedure and was more probably due to the systemic disease progression rather than the spread of cancer cells from the ablated area. Because the ablated renal tumor is left in situ, it is not available for complete pathological evaluation. Hence, definitive histopathological confirmation about the diagnosis, margins and completeness of tumor cell killing cannot be obtained after pRFA [10]. These issues have led many investigators to perform percutaneous biopsy before or in conjunction with an ablation procedure. In our cases, needle biopsy was made only 3 times, where there was a suspicion of angiomyolipoma. The needle biopsy of a small lesion is not helpful in differentiating benign from malignant tumors, as most solid masses are composed of a heterogeneous population of cells and sampling errors are common. For effective ablation, the temperature within the neoplastic mass should exceed 70°C [11]. We finished RFA after reaching this temperature.

At present, the only imaging modality to observe the lesion in real time remains MRI; RFA causes a predictable loss

Table 1. Characterization of patients and tumors undergoing radiofrequency ablation (RFA).

Patient no.	lesion mm	only kidney	Kidney&Location	Age	Other informations	Complications	F-U months
1	35	x	left, lower, mid, exophytic	64	2 RFA procedures, incomplete tumor destruction after 1 RFA		53
2	30	x	left, upper, mid exopytic	67		temporary dialysis	42
3	18		right, lower, mid, parenchymal	67	AML, needle biopsy	neuralgy, shingles	36
4	29		right, lower, mid, exophytic	72	needle biopsy, right kidney tumor with liver metastasis		24
5	45	x	left, mid, exophytic	50			36
6	50	x	right, lower, mid, exophytic	40			33
7	47		left, lower, mid, exophytic	52			33
8	40		right, lower, mid, parenchymal	61			42
9	27	x	right, lower, mid, exophytic	58		increase in serum creatinine level, fever	21
10	43		left, upper, mid exopytic	83			33
11	50	x	right, lower, mid, exophytic	72	tumor recurrence after NSS		27
12	40		right, lower, mid, exophytic	83			21
13	46	x	right, lower, mid, exophytic	79			30
14	46		left, lower, exophytic	71			36
15	55	x	left, upper, mid exopytic	57			24
16	26		right, lower, exophytic	28	AML, needle biopsy		30
17	51		left, lower, mid, exophytic	83	Parkinson disease		18
18	51		left, mid, parenchymal	59	NYHA 3		30
19	59	x	left, lower, mid, exophytic	72	2 RFA procedures, metastasis to adrenal gland, incomplet tumor destruction		42
20	34		right, upper, exopytic	68			30
21	41		right, upper, exopytic	82	Aneurysma Aortae Abdominalis		30
22	47		left, mid, parenchymal	74			18
23	27		right, upper, exopytic	65			27
24	43		right, lower, mid, exophytic	83			30
25	35		right, mid, exophytic	75			30
26	28		right, lower, mid, exophytic	77	left kidney cirrhosis		21
27	33		left, mid, exophytic	65	after chemotherapy of tumor of ovary		18
28	31		left, lower, mid, exophytic	82			45
29	31		left, upper, exopytic	79			27
30	38	x	right, mid, exophytic	73		increase in serum creatinine level, fever	30
31	24		right, upper, exopytic	65			27
32	18	x	left, lower, exophytic	68			30
33	47		right, upper, exopytic	75	2 RFA procedures, incomplete tumor destruction after 1 RFA		24
34	30		left, lower, mid, exophytic	61			30
35	34	x	right, upper, exopytic	59			21
36	40		left, mid, exophytic	76			18
37	28		right, upper, exopytic	68			30
38	42	x	left, lower, mid, parenchymal	76			27
39	33	x	left, mid, exophytic	68			30
40	29		right, lower, parenchymal	59			33
41	47		left, upper, exopytic	73			18
42	34		right, mid, exophytic	76			24
43	32		left, upper, exophytic	79			15
44	30		left, lower, exophytic	41			15
45	30		left, lower, exophytic	73	coronary artery disease		9
46	37		right, upper, exopytic	67			9
47	30		right, lower, exopytic	71			9
48	44		right, lower, exopytic	77			9
49	22		left, lower	50	tumor recurrence after NSS		9
50	31		left, upper, exophytic	55			9
51	28	x	right, upper, exopytic	72			9
52	18		right, upper, exopytic	43			9
53	25		right, upper, exopytic	78			6
54	20		left, mid, exophytic	34	AML, needle biopsy		6
55	53		left, mid, exophytic	73			

of T1 signal [12, 13, 14]. However, there is only a limited opportunity to perform RFA under MRI guidance. Follow-up after renal ablative therapy remains controversial. There is no perfect tool for detecting recurrences. The absence of contrast enhancement on CT does not exclude the presence of viable cancer cells. The results of some studies showed an absence of total tumor necrosis and presence of neoplastic cells after ablation [15, 16]. The development of MSCT has improved detection, characterization and the staging of small renal tumors. MSCT eliminates respiratory misregistration, decreases the partial volume effect, allows for image acquisitions during optimal contrast enhancement and is widely available. Accurate imaging of a patient with suspected renal cell carcinoma (RCC) requires a combination of sequences. Many different protocols have been described in the literature [17, 18, 19]. Un-enhanced CT scans are required to identify calcification. Accurate analysis of renal masses requires the use of an intravenous contrast medium which is associated with a risk of contrast reaction and is potentially nephrotoxic. The ability of MRI to characterize renal masses has improved, but protocols vary widely and usually include pre- and post-contrast images [20, 21]. The use of gadolinium or CO (2) as alternative contrast media to avoid the risk of nephrotoxicity cannot be substantiated by clinical trials and therefore cannot be recommended. Moreover, gadolinium-based contrast media can cause contrast medium-induced nephropathy even at doses below 0.2 mmol/kg body weight in patients with multiple risk factors [22].

Conclusions

Percutaneous RFA is a minimally invasive technique which seems to represent an attractive and promising alternative for patients with small renal tumors. Using 3-phase MSCT has significantly improved the imaging of renal mass, including not only optimal treatment planning but a reliable monitoring of tumor destruction after RFA.

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