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ORIGINAL ARTICLE

CME

Percutaneous Image-guided Radiofrequency Ablation of Renal Neoplasms: Seven-year Local Experience

WK Tsang[1], SF Lee[2], HY Cheung[3], PY Lui[2], KY Tam[2]

[1]Department of Diagnostic Radiology and Nuclear Medicine, Tuen Mun Hospital, Tuen Mun, Hong Kong;
[2]Department of Radiology, and [3]Department of Surgery, North District Hospital, Sheung Shui, Hong Kong

ABSTRACT

Objective: *To evaluate the safety and efficacy of image-guided radiofrequency ablation of renal neoplasms in our centre in Hong Kong.*

Methods: *Records of all patients who underwent this procedure in our centre from February 2004 to March 2011 were retrospectively reviewed. The indications for non-surgical treatment, individual tumour characteristics, procedural details, complications, and follow-up results were evaluated.*

Results: *Over the study period, seven renal tumours from seven patients were treated with radiofrequency ablation. The most common reasons for non-surgical treatment were comorbidities and anticoagulant-related bleeding diatheses. All the patients were male, and had a mean age of 70 (standard deviation, 10.6) years. Six tumours from six patients were included under the intention-to-cure group; five tumours in this group were small (≤3 cm) and exophytic, while one was large (>3 cm) and parenchymal. One patient with bilateral renal cell carcinomas was included for palliation of haematuria. His 11-cm locally advanced left renal cell carcinoma was ablated. In total, 10 sessions of radiofrequency ablation were performed. Four patients had a single ablation session and three underwent two ablation sessions. Technical success without major complication was achieved in all sessions. There was complete tumour eradication in the entire intention-to-cure group after one (n=4) to two (n=2) ablation sessions. In the patient receiving palliation, radiofrequency ablation transiently aborted his disabling haematuria.*

Conclusion: *Percutaneous image-guided radiofrequency ablation can be a safe and highly effective treatment for small renal tumours in favourable positions. This technique could be regarded as a nephron-sparing treatment for non-surgical candidates. It also has a role in palliation of metastatic or locally advanced disease.*

Key Words: *Carcinoma, renal cell; Catheter ablation; Kidney neoplasms; Treatment outcome*

中文摘要

經皮穿刺影像引導下射頻消融治療腎腫瘤：七年本地經驗

曾慧勤、李醒芬、張皓琬、呂沛欣、譚家盈

目的：評估香港一所中心進行經皮穿刺影像引導下射頻消融術治療腎腫瘤的安全性及成功率。

方法：回顧從2004年2月至2011年3月於本中心接受影像引導下射頻消融術的腎癌患者的病例紀錄，

Correspondence: Dr Kassel WK Tsang, Department of Diagnostic Radiology and Nuclear Medicine, Tuen Mun Hospital, 23 Tsing Chung Koon Road, Tuen Mun, New Territories, Hong Kong.
Tel: (852) 2468 6691; Email: tsang_k@yahoo.com.hk

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評估非手術治療適應症、腫瘤的個體特徵、治療程序細節、併發症及隨訪結果。

結果：研究期間共7名腎腫瘤患者（7例）接受射頻消融術。進行非手術治療的最普遍原因為患者有並存病以及因機體抗凝引致的出血傾向。所有病人均為男性，平均年齡70歲（標準差10.6歲）。6名患者（6例）屬意向治癒組，其中5名患者有小腫瘤（即3 cm或以下）並屬外生性，另1名患者有大腫瘤（即3 cm以上）並屬實性。1名有雙側腎細胞癌的病人為緩解血尿症狀而被納入舒緩治療組，對其局部晚期的左腎細胞癌（11 cm）進行消融術。總計操作完成了10次射頻消融術。4名患者接受單次的消融術，另3名患者接受兩次的消融術。在研究期間各消融術均達至技術性成功並沒有嚴重的併發症。意向治癒組中分別接受單次消融術（4例）及兩次消融術（2例）的6名病人的腫瘤均得以治癒。另1名接受舒緩治療的患者，其持暫性的血尿均能在每次射頻消融後的1個月內完全停止。

結論：對於體積小並處於優勢位置的腎腫瘤，經皮穿刺影像引導下射頻消融治療不但安全，而且高度有效。對選擇非手術方法的患者來說，射頻消融可視作一種腎單位保留術。而對於腫瘤轉移或有局部進展的患者來說，射頻消融有緩解的作用。

INTRODUCTION

The incidence of renal cell carcinoma is increasing globally. Around two-thirds of the tumours are diagnosed incidentally in asymptomatic subjects. In such cases they are usually small and localised. A considerable number of clinical studies have shown that partial nephrectomy and laparoscopic nephrectomy achieve treatment outcomes for small tumours that are comparable to traditional radical nephrectomy. Although being less invasive than radical nephrectomy, they nevertheless confer considerable risks in some patients and are not suitable for persons subject to multiple renal tumours throughout their lives. In such cases, image-guided radiofrequency ablation (RFA) may be helpful. In Hong Kong, the role of RFA as a cure for hepatocellular carcinoma and liver metastases has been well-established. However, its use in the treatment of renal tumours is less widely accepted. In this study, we set out to assess its efficacy and safety in the treatment of renal tumours by reviewing all the patients who underwent this procedure in our centre over a 7-year period.

METHODS

Medical records of all patients who received combined ultrasound (US)– and computed tomography (CT)–guided RFA of renal neoplasms in the New Territories East Cluster (Hong Kong) from February 2004 to March 2011 were retrospectively reviewed. Written informed consent was obtained from all patients. The indications of RFA, individual tumour characteristics, procedural techniques, procedure-related complications, pre- and post-procedure haemoglobin levels, and follow-up imaging results were evaluated.

Patients' Demographic Data and Indications for Radiofrequency Ablation

During the study period, seven patients underwent combined US- and CT-guided RFA treatment of renal neoplasms. Before ablation, they all had contrast CT scans of the kidneys. Two of them had histological proof of renal cell carcinoma, while in the rest the diagnosis was based on CT findings.

All the patients were assessed and referred for RFA treatment by the urology team. All of them were male. They had a mean (standard deviation [SD]) age of 70 (10.6) years and an age range of 48 to 79 years. The indications for RFA in the intention-to-cure group (n = 6) were comorbidities, including end-stage renal failure, valvular heart disease, coronary artery disease, a history of cerebrovascular accident, and chronic obstructive pulmonary disease; two had a bleeding diathesis due to anticoagulation; one was immunocompromised; and one had poor renal function and an atrophic contralateral kidney. The six patients in the intention-to-cure group had single renal tumours. Patients who were fit for surgery and those who had metastatic or locally advanced disease were excluded from this group. In one patient, RFA was opted for because of metastatic bilateral renal cell carcinomas warranting palliation for disabling haematuria.

Tumour Characteristics

Six tumours from six patients were included in the intention-to-cure group. The tumour diameters ranged from 1.5 to 3.2 cm, with a mean (SD) diameter of 2.3 (0.6) cm. Five tumours were 3 cm or smaller (range, 1.5-2.5 cm), and one was slightly larger (3.2 cm). Four tumours were located in the left kidney (upper pole, n = 1; lower pole, n = 3) and two in the right kidney (upper pole, n = 2). Three tumours were located at the posterior cortex, two at the lateral cortex, and one at the medial cortex (Figure 1). According to their location, the tumours were classified as exophytic, central, parenchymal, and mixed (Figure 2); five were exophytic and one was parenchymal. In the patient receiving palliation, his tumour was classified as mixed, as it had replaced the whole left kidney and invaded both the renal sinus and perirenal fat.

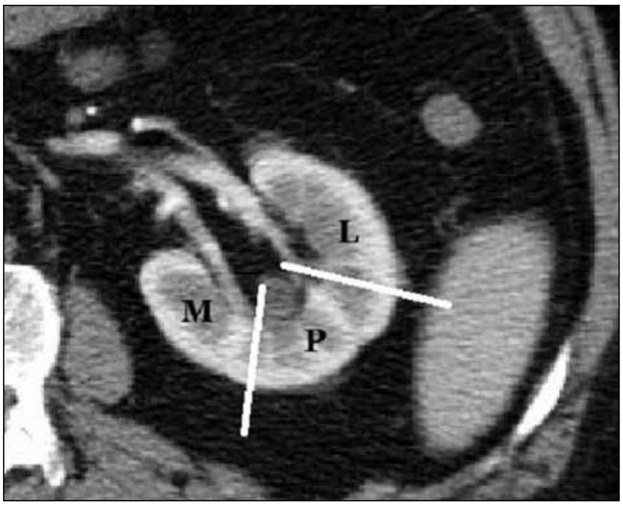

Figure 1. The renal cortex can be divided into three equal parts and classified as lateral (L), posterior (P), and medial (M) cortex.

Ablation Technique

All the patients had their haemoglobin level, renal function, and international normalised ratio (INR) checked on the day of ablation or a day earlier. To the best of our knowledge, there was no consensus about the effectiveness of prophylactic antibiotics for patients undergoing RFA of renal tumours. Some operators gave empirical antibiotics as a routine as recommended by the Royal College of Radiologists while others only gave them selectively. In our study, all the patients had an increased risk of infection as they were immunocompromised (due to diabetes mellitus, end-stage renal failure, or advanced age). Therefore they all received a single dose of intravenous antibiotics (cefuroxime 1.5 g or ciprofloxacin 200 mg) prior to the procedure. Apart from the well-recognised causes of being immunocompromised, some studies show that patients with ileal conduits and ureteric stents are at a higher-than-normal risk of upper urinary tract infection. Therefore we advocate the use of prophylactic antibiotic in all such patients.

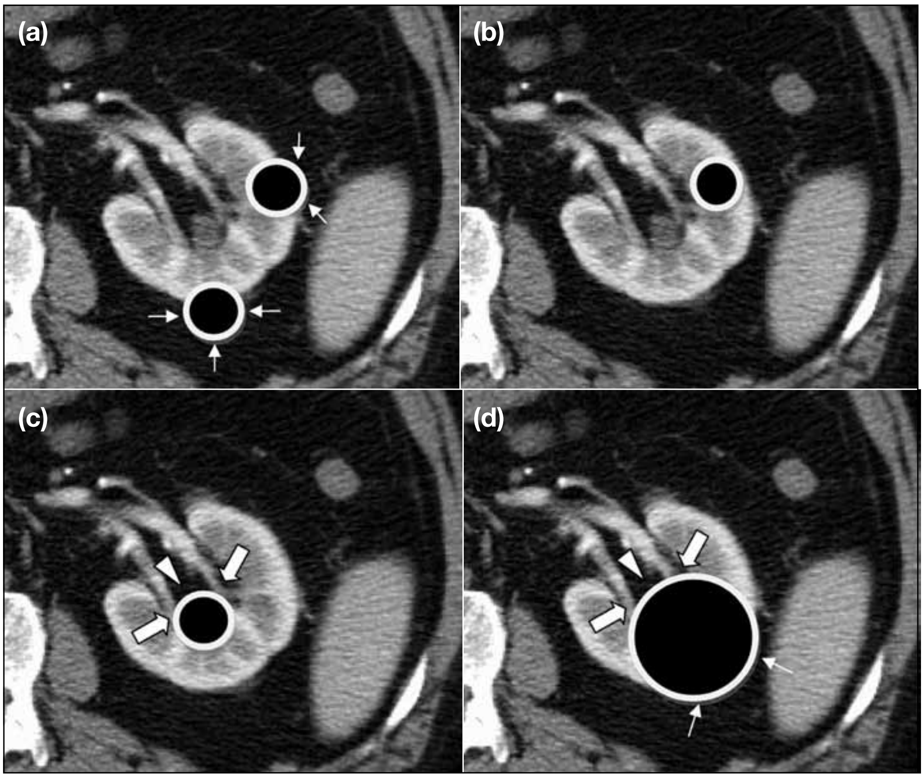

Figure 2. The location of the tumour can influence radiofrequency ablation (RFA) results based on its contact with the perirenal fat, renal parenchyma, and central vessels. The tumour is considered (a) exophytic when 25% or more of its diameter is in contact with the perirenal fat (arrows), and (b) parenchymal when it is completely surrounded by renal parenchyma without protruding into the perirenal fat or central sinus. (c) The tumour is central when it protrudes into the central sinus fat (arrowhead) without contacting the perirenal fat. (d) The tumour is regarded as mixed in location when it protrudes into both the central sinus (arrowhead) and perirenal fat (thin arrows). Note the proximity of the central vessels with the central and mixed tumours (thick arrows), which can cause a heat-sink effect that decreases the effective ablation volume.

Local anaesthesia with 2% lignocaine was given at the site of electrode insertion. Systemic analgesia and conscious sedation was used on an individual basis, and there was continuous monitoring of vital signs (blood pressure, pulse rate, and oxygen saturation) throughout the procedure.

All the combined US- and CT-guided RFAs were performed in two regional hospitals under the New Territories East Cluster (Prince of Wales Hospital and North District Hospital) by a single experienced interventional radiologist with more than 10 years of relevant experience. Two types of needle electrodes were used. One was the single / cluster exposure tip Cool-Tip needle (Valleylab™, Tyco Healthcare Group, USA) connected to a Cool-Tip Generator™. The other was a single tip LeVeen CoAccess™ needle electrode (Boston Scientific, USA) connected to an RF3000R Generator. The type of electrode and length of the exposure tip depended on operator preference. The first consideration was on technical aspects. The Cool-Tip needle has the advantage of being flexible and can be adjusted after insertion. Thus, fine-tuning of its position is feasible during and after the ablation cycle. By contrast, the position of the LeVeen needle is relatively stable once deployed. Being a trocar needle the Cool-Tip needle has a relatively smaller calibre which makes it less traumatic than the LeVeen needle. Also, it is easier to be visualised by US. The geometry of the planned ablation zone is another factor to consider. Notably, when using the LeVeen needle, the width of the ablated zone appears larger than its vertical length. The reverse applies when using the Cool-Tip needle. For lesions larger than 3 cm, a cluster probe should be used as a larger ablation zone can be more readily achieved within a reasonable time frame.

In both electrodes, iced saline was used to cool down the electrode tip. The electrode was inserted under combined CT and US guidance. After favourable positioning of the Cool-Tip needle, the tumour was ablated for 12 minutes till 50°C was reached. For the LeVeen system, the ablation ended automatically, which was determined by the change in impedance, resistance, and conductivity of the tissues. We usually set a 15-minute cycle and in most cases the ablation cycle terminated within this time frame. After that, in the intention-to-cure group the electrode was placed in a different location of the tumour as needed, with the aim of ablating the whole tumour. For palliation, the hypervascular portions of the tumour were ablated. Tract ablation was also carried out for tumours that measured 3 cm or more.

Post-procedural Care

Post-procedural unenhanced CT was performed after every ablation session to look for any immediate complication. The patients were then monitored till they were transferred back to clinical wards. The haemoglobin level and renal function were checked after the procedure. Any post RFA complication or recourse to blood transfusion during the patients' hospital stay was documented.

Imaging Follow-up

All patients were followed up with serial contrast CT scans of the kidneys within the first 3 months following ablation. All the CT scans were interpreted by radiologist fellows. Residual tumour was defined as an area at the ablation edge with a post-contrast increase in the attenuation of more than 10 HU or with interval growth in serial CT scans. Patients with residual tumour were retreated by RFA.

RESULTS

In all, 10 sessions of RFA were performed on seven renal tumours in seven patients. Four patients from the intention-to-cure group received a single ablation session; three patients including two from the intention-to-cure group and one having palliation received two ablation sessions.

Local analgesia (with 2% lignocaine) at the site of electrode insertion was given to all patients. Systemic analgesia in the form of pethidine (50 mg) was given at the beginning of three sessions and conscious sedation in form of midazolam (3 mg) was given for one session.

All the patients were placed prone with all the tumours targeted via the posterior approach. Satisfactory needle placement could be achieved in all cases. A total of 23 separate ablations were performed in 10 sessions. All five tumours with diameters ≤3 cm received two ablations in each session. Due to their small size and exophytic location, no renal parenchyma was traversed during needle placement. Therefore tract ablation was not performed as the risk of haemorrhage or tumour seeding was low.

The two tumours exceeding 3 cm in diameter received three ablations per session, and tract ablation was performed in each case, as the risk of haemorrhage or tumour seeding was deemed significantly higher in view of a considerable amount of renal parenchyma was traversed by the electrode. In the patient having palliation, three hypervascular areas were ablated. Trucut biopsies of the renal tumour at the beginning of RFA session were performed in two patients, both confirmed histologically to be renal cell carcinomas.

In the patient having palliation, a co-axial needle of 14G and a 3-cm LeVeen needle of 15G were used in the first session so as to facilitate renal biopsy before ablation. A 3.5-cm LeVeen needle of 15G was used in the second session. Tract embolisation with Gelform was performed in both sessions. In the intention-to-cure group, a 17G Cool-tip needle was used in four sessions, with a 2.5-cm and 3-cm needle, both being used in two sessions. A 3-cm 15G LeVeen needle was used in one session. A LeVeen needle of 17G was adopted in three sessions, with a length of 2 cm in one session and 3 cm in two.

Complication

Minimal perinephric haematomas were noted at the end of two ablation sessions in both patients on warfarin. The INR was normal in one patient (patient 2) and elevated (1.4) in the other (patient 5). None of them had a significant decrease in haemoglobin level or received a blood transfusion. Their perinephric haematomas resolved with conservative treatment.

There was no immediate complication following the remaining ablation sessions. None of the patients

Table. Characteristics of patients, tumours, radiofrequency ablation technique, and outcome.

Patient No.	Age (years) / sex	Presentation	Comorbidities	Tumour site	Tumour type	Tumor size (cm)	No. of ablation sessions	No. of ablations	Needle type / gauge (G) / length (cm)	Summary of outcome
Intention-to-cure group										
1	48 / M (Figure 3)	Incidental	ESRF with renal transplant on immunosuppressant and steroid, bilateral lower limb DVT on warfarin	Left lower pole, posterior cortex	Exophytic	1.9	2	visit 1: 2 visit 2: 2	Cool-tip / 17 / 2.5 Cool-tip / 17 / 2.5	No residual / recurrent tumour at 13.8 mo after 2nd ablation
2	65 / M (Figure 4)	Incidental	Valvular replacement on warfarin, on pacemaker, coronary artery disease, COPD, AF, HT, renal impairment, hyperlipidaemia	Left upper pole, posterior cortex	Exophytic	2.5	2	visit 1: 2 visit 2: 2	Cool-tip / 17 / 3 Cool-tip / 17 / 3	No residual / recurrent tumour at 13.5 mo after 2nd ablation
3	73 / M	Incidental	Mitral regurgitation, HT, DM, hyperlipidaemia	Left lower pole, lateral cortex	Exophytic	1.5	1	2	LeVeen / 17 / 2	No residual / recurrent tumour at 20.8 mo after single ablation
4	79 / M (Figure 5)	Incidental	Atrophic contralateral kidney with poor function, COPD, HT, history of malignancy, GIST	Left lower pole, medial cortex	Parenchymal	3.2	1	3	LeVeen / 17 / 3	No residual / recurrent tumour at 38.5 mo after single ablation
5	76 / M	Incidental	AF on warfarin, mitral regurgitation, DM, history of retroperitoneal haematoma	Right upper pole, lateral cortex	Exophytic	2.5	1	2	LeVeen / 17 / 3	No residual / recurrent tumour at 36.2 mo after single ablation, succumbed at 84 mo due to pneumonia
6	74 / M	Incidental	Old stroke, HT, DM, duodenal ulcer with haemorrhage	Right upper pole, posterior cortex	Exophytic	2.2	1	2	LeVeen / 15 / 3	No residual / recurrent tumour at 46 mo after single ablation, succumbed at 69 mo due to intestinal obstruction
Palliation group										
7	75 / M	Haematuria with acute retention of urine	Bilateral renal cell carcinoma, AF, COPD, history of thyroid carcinoma	Entire left kidney	Mixed	11	2	Visit 1: 3 Visit 2: 3	Coaxial / 14; LeVeen / 15 / 3 Coaxial / 14; LeVeen / 15 / 3	Transient control of haematuria after each ablation, succumbed at 12 mo after 2nd ablation due to poor general condition

Abbreviations: AF = atrial fibrillation; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; DVT = deep vein thrombosis; ESRF = end-stage renal failure; GIST = gastrointestinal stromal tumour; HT = hypertension; RFA = radiofrequency ablation.

experienced a significant decrease in haemoglobin level or deterioration in renal function during their post-procedural hospital stays. None of them had any long-term complication during follow-up.

Follow-up

A brief summary of the treatment results is listed in the Table and illustrated in Figures 3 to 5. All the patients had their first follow-up CT scan of the kidneys within 3 months of their first ablation. Any residual or recurrent tumour was retreated with RFA. In the intention-to-cure group, the follow-up period ranged from 14 to 46 months with a mean of 27 months from the last ablation. The patient having palliation had his last CT 28 days after the second ablation. The clinical progress of all these patients were traced via the Electronic Patient Record. Their follow-up period ranged from 14 to 84 months.

Three patients had succumbed 12 months or beyond after last ablation. All of them died from causes unrelated to their renal tumours. In patients who survived at the end of the follow-up period, none had clinical or radiological suspicion of tumour recurrence.

In the intention-to-cure group, there were five patients with small (≤3 cm) exophytic tumours; three of them received single ablation session and were free of residual / recurrent tumour at 21 to 46 months after ablation. Two patients had residual tumour after the first ablation session, and were retreated by RFA and remained free of residual / recurrent tumor 14 months after the second ablation. One tumour in the intention-to-cure group was large (3.2 cm) and parenchymal in location. It was successfully eradicated after a single ablation session and had no evidence of residual / recurrent tumour at 18 months.

In the patient offered palliation, his locally advanced left-sided tumour (11 cm) was ablated twice. The disabling haematuria ceased for around 1 month after each ablation session, but RFA was not repeated due to the patient's poor general condition.

Summary of Treatment Outcome

All tumours in the intention-to-cure group were

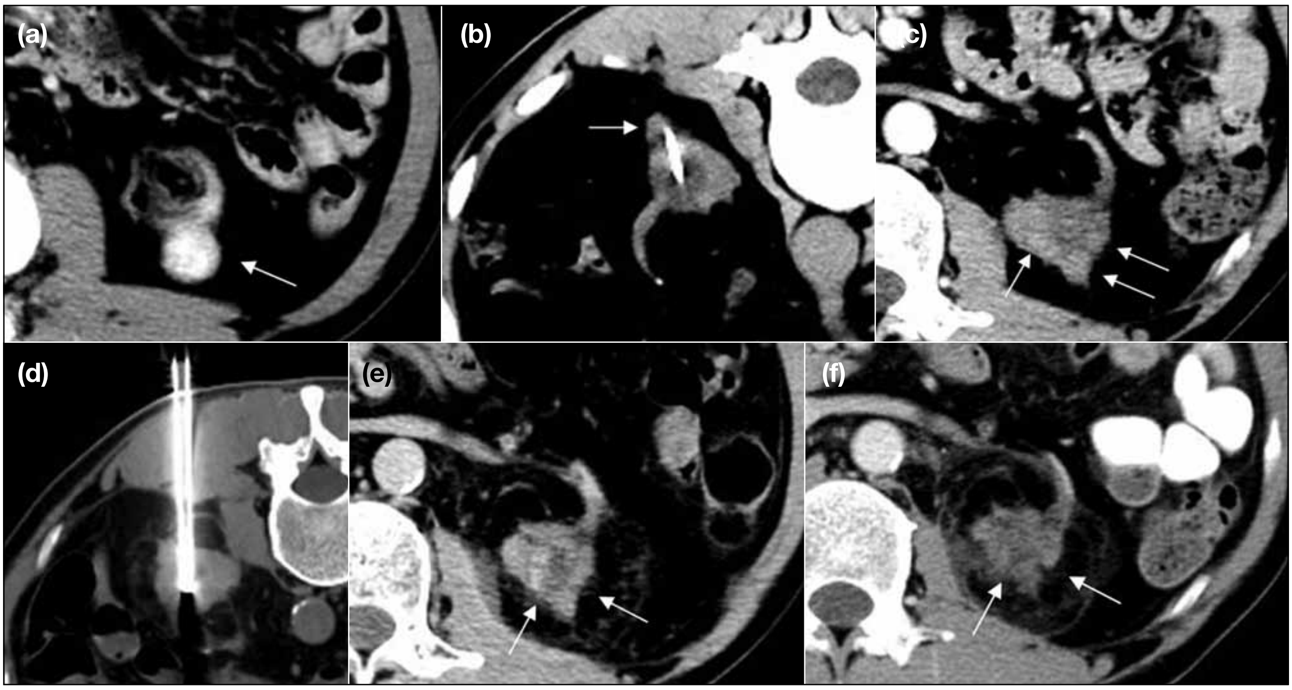

Figure 3. A 48-year-old male with end-stage renal failure: (a) Incidental finding of a 1.9-cm enhancing exophytic tumour at the posterior cortex of lower pole of left kidney (arrow). Around three-fourths of its diameter is in contact with the perirenal fat. (b) Combined ultrasound and computed tomography (CT)–guided radiofrequency ablation performed with a 2.5-cm 17G Cool-tip electrode (arrow) using the posterior approach, with the patient prone. (c) Peripheral enhancement at the edge of ablation zone in the CT at 3 months (arrows), suggesting residual tumour. (d) A second ablation was performed for residual tumour. No peripheral arterial enhancement of more than 10 HU at the ablation edge (arrows) to suggest residual or recurrent tumour in the CT undertaken (e) 3 months and (f) 14 months after re-ablation.

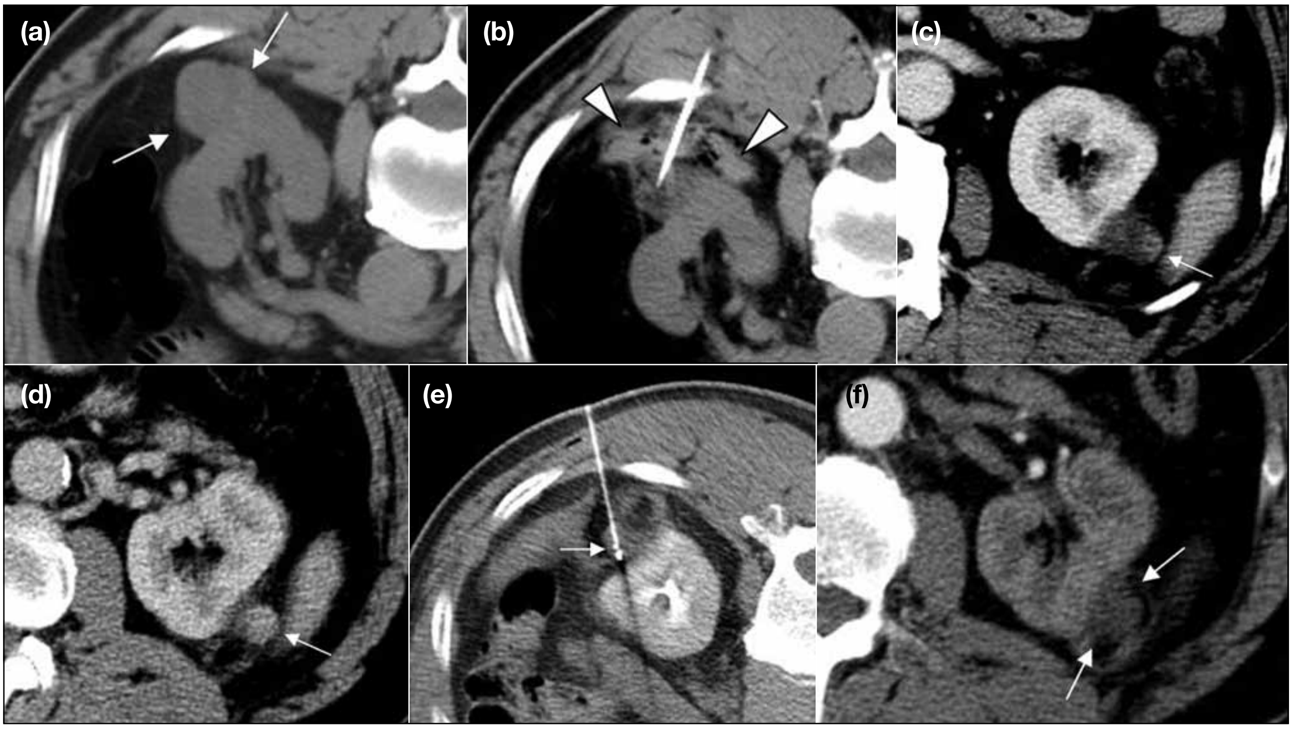

Figure 4. A 65-year-old male with valvular replacement on warfarin with (a) an incidental 2.5-cm exophytic tumour at the posterior cortex of the upper pole of the left kidney (arrows). Around three-fourths of the tumour is surrounded by perirenal fat. (b) Combined ultrasound (US) and computed tomography (CT)–guided radiofrequency ablation was performed with a 3-cm 17G Cool-tip electrode via posterior approach. A small perinephric haematoma is evident in the posterior perirenal fat (arrowheads). (c) Contrast CT scan of the kidneys 1 week after ablation shows a small enhancing focus at the lateral ablation edge (arrow), which had markedly enlarged in the CT performed at (d) 5 months, and was consistent with residual tumour (arrow). (e) Ablation was repeated under combined US and contrast CT guidance for accurate delineation of the residual tumour (arrow). (f) No peripheral arterial enhancement of more than 10 HU at the ablation edge to suggest residual or recurrent tumour at 14 months after the second ablation (arrows).

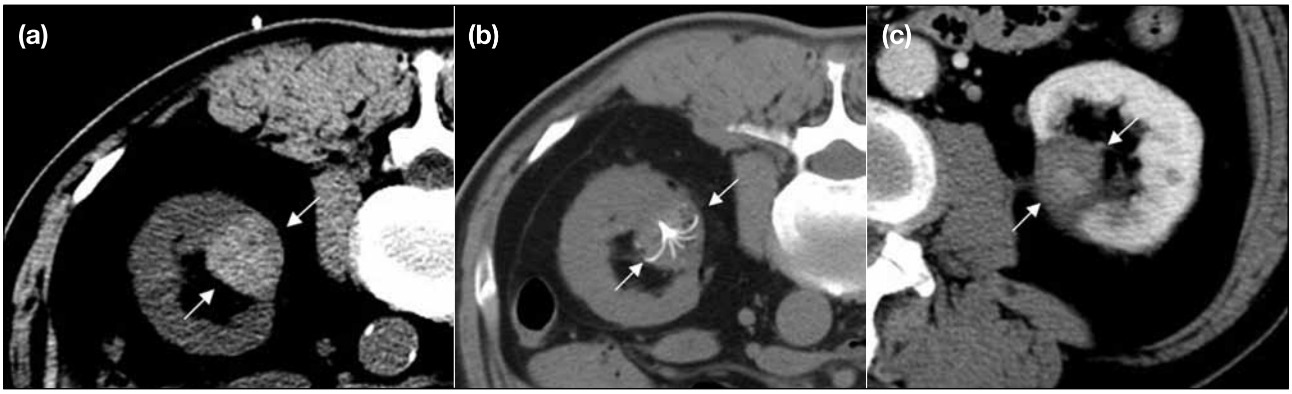

Figure 5. A 79-year-old male with an atrophic right kidney and poor renal function: (a) Incidental finding of a 3.2-cm parenchymal tumour at the medial cortex of lower pole of left kidney. The tumour is completely within the renal parenchyma without extension to the renal sinus or perirenal fat (arrows). (b) Combined ultrasound and computed tomography (CT)–guided radiofrequency ablation performed with a 3-cm 17G LeVeen electrode via posterior approach (arrows). (c) No peripheral enhancement at the edge of ablation zone is noted in the CT at 39 months (arrows).

successfully treated after one or two ablation sessions, with no evidence of residual / recurrent tumour 14 to 46 months after the last ablation. Temporary elimination of the disabling haematuria was achieved in the patient having post-ablation palliation.

DISCUSSION

Treatment Options in Renal Tumours

There is a globally increasing trend in the incidence of renal tumours.[1-7] In Hong Kong, there was more than a 50% increase in both the number of new cases and mortality over the last 10 years.[8] Radical surgery is still regarded as the gold standard in the management of organ-confined tumours, and historically radical nephrectomy has been considered a surgical option in patients with a normal contralateral kidney. Recently, a considerable number of clinical studies have shown that compared to radical nephrectomy, partial nephrectomy and laparoscopic nephrectomy achieve comparable treatment outcomes for small tumours.[1] However, this might not be feasible in some patients, such as those with multiple comorbidities, advanced age, short life expectancy, metastatic and locally advanced disease, and a high lifetime risk of developing multiple renal tumours (as in those with Von Hippel-Lindau syndrome). These reasons, together with the increasing incidence of small, organ-confined tumours, encourage the development of image-guided percutaneous ablation. These methods of ablation are either thermal (e.g. RFA, microwave, cryoablation) or non-thermal (e.g. chemical, irreversible electroporation), or a combination of both.[1-7, 9-11] Image-guided percutaneous ablation had many advantages compared to surgery. These included being less invasive, capable of being performed under local analgesia, having a lower complication rate, and having a shorter convalescence. The choice of ablation method depends on the tumour's characteristics, operator expertise and preference, and equipment availability in individual centre.

With the advantages of being widely available, relatively inexpensive and easy to perform, RFA has become the most widely adopted percutaneous ablative technique for renal tumours. RFA works by frictional heat generated by ionic agitation of intracellular molecules from a high-frequency alternating current delivered to the treatment area. Coagulation necrosis of tissue is achieved at around 60°C. Tissues nearest to the electrode are heated most effectively, while more peripheral areas receive heat via thermal conduction. In a considerable number of clinical studies, for small tumours percutaneous RFA is proven to have a comparable success rate to nephrectomy for complete tumour eradication. The most prominent problems of RFA are: (1) its efficacy heavily relies on tissue electrical conductivity, thermal conductivity, and heat impedance; and (2) the heat-sink effect caused by the presence of large vessels around the RFA zone that reduces the size of the ablation zone and can result in local tumour progression

In contrast to RFA which uses heat generation, cryoablation works by rapid freezing followed by thawing.[12] Freezing to -30° to -40°C results in cell death from cellular dehydration, cell membrane rupture, and vascular thrombosis. Compared to RFA, the ablation zone per cryoprobe is smaller, and therefore several applicators have to be used in most instances. In general, one cryoprobe generates an ice ball of 2 cm along the short axis. Thus, to achieve a 10-mm margin, two to three cryoprobes are needed for tumours measuring 1-3 cm. The main advantages of cryotherapy over RFA are: (1) ability to use multiple probes at the same time, thus can achieve a larger ablation volume in a shorter period, and (2) cryoablated lesions are clearly demarcated from the adjacent normal tissue, which facilitates continuous monitoring of the iceball (if necessary). The main problem of cryotherapy is its relatively non-availability in different centres. In addition, there are two potentially lethal complications which are unique to cryoablation. They are cracking of cryolesions and cryoshock. Cracking of the iceball can cause significant post-ablation bleeding that contributes to 8% of post-cryotherapy morbidity. Cryoshock is rare and characterised by varying degrees of severe coagulopathy, disseminated intravascular coagulation and multi-organ failure after cryoablation.

Microwave ablation is an evolving thermal ablation measure, showing promise for the treatment of renal tumours in several phase 1 studies.[13] Microwave energy directly radiates into the tissues through antenna, which function to transfer energy from the power-generating source. Water molecules in the surrounds become agitated and produce frictional heat, which induces cell death in a volume of tissue around the antenna. In contrast to RFA, microwaves can propagate through and heat up different types of tissue effectively, even those with low electrical / thermal conductivity and high impedance. Compared to RFA, microwave ablation has the advantages of being able to achieve higher intratumoural temperature and larger ablation volume. Also, microwave energy is not subject to heat-sink effect. The major drawback of microwave ablation are its high cost, and only a limited number of small-scale phase 1 studies supported its efficacy.

Tumour Factors Affecting Success of Radiofrequency Ablation

Tumour size has been a major determinant of treatment success. It is generally accepted that increase in tumour size correlates with a decrease in the rate of complete eradication.[1] In a study of 125 renal cell carcinomas,[2] all tumours less than 3.7 cm achieved tumour-free survival after a single ablation session, compared with 47% for lesions of 3.7 cm or larger. In our study, the slightly large (3.2 cm) parenchymal tumour could be successfully eradicated with three ablations in a single session. Three of the five small exophytic tumours were eradicated after a single ablation, while the remaining two needed two ablation sessions. However, the relationship between the tumour size and treatment success cannot be inferred from our study due to the small sample size.

Tumour location is another predictor of treatment success with RFA. An exophytic location is a proven independent factor favouring complete tumour necrosis,[2] probably due to its easier accessibility for ablation. The insulating effect of the relatively avascular perirenal fat, the so-called 'oven effect', augments effective ablation. By contrast, central tumours are more difficult to treat, because (1) their proximity to the central vessels and collecting system can cause difficulty in electrode placement, and (2) the heat-sink effect caused by surrounding vascular renal parenchyma and adjacent major vessel decreases the effective ablation volume. However, the relationship between the tumour location and the treatment success could not be inferred from our findings, as none of the tumours in our series was centrally located.

The role of RFA as a palliative measure in metastatic and locally advanced renal cell tumours has not been extensively investigated. One study reported that no tumour larger than 5.5 cm could be completely ablated in single ablation session.[2] In our study, one patient with bilateral renal cell carcinomas was included for palliative ablation of his locally advanced left renal tumour. The hypervascular zones, which were presumed to be the major site of bleeding causing his disabling haematuria, were ablated. His haematuria was transiently aborted in the month after each ablation session. We therefore advocate RFA as a treatment option for patients with symptomatic locally advanced renal tumours.

Complications and Prevention

The most common complication of RFA of renal tumours is perinephric haemorrhage, as occurred in our series. The frequency of haemorrhage after RFA is lower than that following cryotherapy, probably due to the former's coagulative effect. In patients with a high chance of bleeding as in the presence of impaired coagulation, a large hypervascular tumour, biopsy at the beginning of RFA session, or the use of a relatively large electrode, tract ablation and embolisation (with gelfoam or tissue glue) are advocated.

Pneumothorax or lung injury can result from ablation at the upper pole tumours. A small asymptomatic pneumothorax usually resolves with conservative treatment, while for a large and progressive one, chest drain insertion is warranted. If thoracic cavity cannot be avoided in the path of electrode insertion, pre-procedural iatrogenic hydrothorax should be considered. The mandatory use of dextrose solution to create an artificial hydrothorax cannot be overstressed, as ionic saline can conduct a current and cause heat dispersal, which in turn decreases the effectiveness of RFA. An alternative to decrease the chance of lung injury is iatrogenic pneumothorax.

Thermal injury of the ureter is a well-known complication of RFA of renal tumours, especially in those that are central and in close proximity to the collecting system. Radiological hints of ureteric injury include urinomas adjacent to the ablation bed and hydronephrosis caused by ureteric stricture. To prevent this potentially serious complication, retrograde ureteral stent placement might be necessary before ablation of central tumour. This allows drip infusion to help cool down the collecting system which decreases the risk of thermal injury.

Besides being directly punctured by the electrode, organs around the kidney can be damaged by thermal injury, especially when they are within 2 cm of the ablation zone. Appropriate patient positioning may help to displace adjacent organs from the kidneys by gravity, e.g. oblique (ipsilateral side up) and feet-down position to displace bowel loops. Sometimes, manual compression may also help. Using the electrode as a lever to exert torque on the kidney and move it away from the surrounding organs is another helpful manoeuvre. Dissection of perinephric space with dextrose or carbon dioxide can also displace organs from the electrode path and ablation zone. Again, as explained it is crucial to use dextrose instead of saline.

Limitation

Our study was limited by having a small sample size, as surgery was still regarded as the standard treatment of fit patients with renal tumours. Moreover, we were in a relatively passive role in terms of patient recruitment as all the cases were referred from the urology team. We opted to share our experience at this early stage to raise awareness of the high efficacy of RFA in the treatment of renal tumours, particularly in those who are not amenable to surgery.

CONCLUSION

Percutaneous image-guided RFA can be safe and highly effective in the treatment of small renal tumours in a favourable location. It could be regarded as a nephron-sparing treatment option for non-surgical candidates. It also has a role in the palliation of patients having metastatic or locally advanced disease.

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