Intermediate Outcomes of Image-Guided Radiofrequency Ablation of Renal Tumours

Dear Editor,

Small renal tumours or T1a renal cell carcinoma (RCC) are increasingly being detected incidentally due to widespread imaging. Radical nephrectomy was historically the standard of care for renal tumours. However, it carries an increased risk of chronic kidney disease, and higher mortality and morbidity compared with nephron-sparing interventions (partial nephrectomy and image-guided ablative techniques).[1] Percutaneous ablative techniques have demonstrated rapid development over the past decade with radiofrequency ablation (RFA) being the most established and well studied modality. In this study, we present our experience with RFA of renal tumours within a South East Asian centre, and discuss the role of ablation in their clinical management.

Materials and Methods

This was a retrospective study of patients who underwent RFA of renal tumours at a single institution between June 2004 and June 2015. Patients were considered for RFA at our multidisciplinary meeting if they were non-surgical candidates due to advanced age, multiple comorbidities, solitary kidney, synchronous renal tumour, von-hippel-lindau disease or impaired renal function. Treatment options were offered to them during consult with the urologist. Those who desired to consider percutaneous RFA would subsequently be reviewed in an interventional radiology (IR) clinic.

Radiofrequency Ablation (RFA)

RFAs were performed at our hybrid computed tomography (CT) interventional suite with patients under conscious sedation. Initial limited CT was acquired for planning needle trajectory. Renal tumour was biopsied immediately prior to ablation except in 7 patients who were treated early in the series. Under ultrasound and/or CT fluoroscopy guidance, the renal tumour was targeted with internally cooled single electrode (Cool-tip, Covidien, Medtronic, Boulder, USA) of varying lengths (15-20 cm with active electrode lengths from 10-30 mm) depending on tumour size and patient's habitus. Single ablation cycle lasting 12 minutes was performed for each tumour with overlapping ablations applied to larger tumours (>3 cm) by repositioning of the electrode. During withdrawal of the RFA electrode, the track was ablated to reduce risk of haemorrhage and tumour seeding. Adjunctive techniques (hydrodissection or cold pyeloperfusion) were employed for renal masses in close proximity to surrounding organs to avoid heat-induced damage. After RFA, all patients were observed overnight and discharged the following day if clinically stable. Earlier in our practice, CECT was performed 1 day after RFA to evaluate for complications. This was subsequently replaced with an immediate post-ablation CT to document ablation zone and exclude complications.

Clinical and Radiological Follow-up

All patients had contrast-enhanced imaging (CT, ultrasound or magnetic resonance imaging) before and after RFA. Post-RFA imaging surveillance was at 1 and 6 months, and annually thereafter. On imaging, the degree of tumour beyond the renal contour classified their growth pattern as exophytic (≥75%), endophytic (≤25%) or mixed (25-75%). To standardise outcome measures, we used terminologies from the International Working Group on Image-Guided Tumour Ablation.[2] Technical success was defined as complete tumour ablation according to protocol, during or immediately after procedure. Primary technique efficacy was defined as tumour eradication with no residual enhancing component (≥20 HU) on the scan within 3 months after ablation. Local recurrence was defined as new enhancing component within the ablation zone after initial negative scan. Secondary technique efficacy was defined as successful repeat ablation of local tumour recurrence. Complications were prospectively recorded.

Follow-up review included clinical assessment and trending of serum creatinine level. Estimated glomerular filtration rate (eGFR) was calculated using the Cockcroft-Gault equation, and eGFRs before and after RFA (at last follow-up) were compared. The overall (OS), cancer-specific (CSS) and recurrence-free survival (RFS) rates were also documented.

Data Analysis

Descriptive statistics were reported and P values <0.05 were considered statistically significant. Univariate analysis was performed using Fisher's Exact test to assess tumour size and location as predictors of technical success, as well as the change in GFR before and after RFA.

Results

A total of 22 patients (8 women, 14 men) with mean age of 71.8 years (standard deviation [SD] = 9.1, range 51-88) were treated. ASA (American Society of Anesthesiologists) scores of the patients were either 2 (n = 15) or 3 (n = 7). Patient profile and tumour characteristics are shown in Table 1. A total of 24 renal tumours (mean diameter, 2.6 cm) were ablated over 29 sessions. Nineteen tumours were completely ablated with a single RFA session whilst 5 tumours required 2 RFA sessions each. The mean diameter of tumours requiring 2 treatment sessions for complete ablation was 3.2 cm (SD = 1, range 2-4.8). Tumour growth pattern and size did not have significant effect on the likelihood of residual tumour ($P = 0.59$, $P = 0.27$). There were minor complications of perinephric haematomas in 6 patients, which were managed conservatively without the need for blood transfusion. There was no major procedure-related complication or mortality. The mean follow-up duration was 56.6 months (range 2-104 months). Outcomes of RFA are summarised in Table 2 and details of patients with residual or recurrent tumour are depicted in Table 3. There were a total of 6 mortalities during the follow-up period. Two developed metachronous RCC with eventual demise related to disease progression. The other 4 mortalities were not RCC-related. Regardless of the patient's baseline renal status (categorised into eGFR >60 and eGFR ≤60), there was no significant change in renal function after RFA respectively ($P = 0.29$ and $P = 0.79$).

Table 1. Patient Demographics and Tumour Characteristics

Previous RCC (%)	4 (18.2)
Radical nephrectomy	2
Partial nephrectomy	2
Indication for RFA	
Advanced age (>80 years)	3
Bilateral disease	2
Prior nephrectomy/single kidney	4
Treatment for existing cancer	3
Patient preference	8
Bleeding tendency	1
Poor renal function	1
No. of tumours ablated	24
Treated side	
Right	10
Left	14
Tumour location	
Upper pole	5
Mid pole	12
Lower pole	7
Tumour growth pattern	
Exophytic	13
Endophytic	4
Mixed	7
Tumour diameter, cm	2.6 (average)
>4 cm	2
2-4 cm	16
<2 cm	4
Renal mass biopsy (%)	17 (77.3)
RCC	16
Benign	1 (oncocytoma)
No biopsy	7

RCC: Renal cell carcinoma; RFA: Radiofrequency ablation

Discussion

RFA is an attractive treatment option for patients in our series who are elderly with multiple comorbidites, prior nephrectomy or bilateral RCCs. We achieved complete control in 91.7% of renal tumours at a mean follow-up of 56.6 months. Despite a small referral volume, technical success rate was comparably high at 95.8% with no major complication requiring treatment or prolonged hospitalisation. The comparatively lower primary efficacy rate at our centre (83.3%) compared to larger series[3-5] is reflective of an early series and we postulate several contributory factors: patient factors limiting positioning and cooperability; suboptimal tumour visualisation on non-contrast, intraprocedure ultrasound (US); and the learning curve of our operators.

As the most established ablative technique, there are emerging results on the longer term oncological durability of RFA in T1a renal tumours.[6,7] Our results, though promising (3-year RFS 94.7%, overall CSS 90.9%), are shorter term and from a much smaller series. Notably, the sizes of

Table 2. Radiofrequency Ablation Outcomes of 24 Renal Tumours

Technical success (%)	23/24 (95.8)
Primary technique efficacy (%)	20/24 (83.3)
Secondary technique efficacy (%)	1/24 (4.2)
Complications (%)	6/29 (20.7)
Local recurrence (%)	2/24 (8.3)
Cancer-specific survival (%)	20/22 (90.9)
Overall survival (%)	16/22 (72.7)
Percentage of recurrence-free survival	
1 year	95.2
2 years	95.2
3 years	94.7

Table 3. Summary of Patients with Residual and/or Recurrent Disease

Age/Gender	Comorbidities	Tumour Characteristics	Indication for RFA	Residual/Recurrent Disease	Intervention	Follow-up
74/M	Gastric carcinoma s/p subtotal gastrectomy	Multifocal bilateral RCC: 1) Right upper pole, 2.1 cm, exophytic 2) Left mid pole, 1.6 cm, exophytic 3) Left lower pole, 3 cm, exophytic	Multifocal bilateral RCC	Residual disease in right upper pole and left lower pole tumours	Repeat ablation at 55 and 81 days, respectively	No local recurrence at 100, 66 and 38 months, respectively
72/F	Left radical nephrectomy for RCC	Right mid pole, 3.3 cm, abuts calyx (cooling with ureteric catheter)	Prior left radical nephrectomy for RCC	Residual disease	Repeat ablation at 40 days	Developed metachronous RCC at 37 months with metastatic progression to lungs and brain
72/F	Cardiovascular risk factors	Left mid pole, 2.8cm, mixed	Patient preference	Residual disease	Repeat ablation at 90 days	No local recurrence at 24 months
80/M	Moderate to severe stage CKD (eGFR 30)	Right upper pole, 4.8 cm, mixed	Advanced age, CKD	Technically challenging RFA, unable to target medial aspect of tumour	Repeat ablation at 19 days	Local recurrence at 28 months; not treated due to age. Slow tumour growth observed on active surveillance till 36 months
66/F	Factor VII deficiency, PRV	Left lower pole, 2.5 cm, exophytic (RFA with fresh frozen plasma cover)	Bleeding tendency	Recurrent disease at 39 months	Repeat ablation at 41 months	Died at 42 months due to PRV-related complication

CKD: Chronic kidney disease; F: Female; M: Male; PRV: Polycythemia rubra vera; RCC: Renal cell carcinoma; RFA: Radiofrequency ablation; s/p: Status post

tumours treated in our study were not limited to stage T1a. For larger renal masses (>3-4 cm), the oncologic efficacy of RFA is mixed with incomplete treatment rates >20% and local progression reported.[8,9]

We found no significant procedure-related complication or deterioration of renal function in our patients, consistent with the well documented safety and nephron preservation (≤25% reduction in GFR) of RFA.[5,10,11] On the contrary, laparoscopic partial nephrectomy is technically challenging with complications up to 33% even in skilled operators.[12,13] This steep learning curve should continue to drive the development and more extensive usage of image-guided tumour ablation. To date, our centre has started adopting newer ablative techniques such as multiple-electrode RFA. Cryoablation, which is also gaining popularity amongst urologists, has inherent advantages which may prove beneficial for T1b or central tumours. It allows real-time monitoring of the ablation zone, has lower susceptibility to perfusion-mediated thermodilution ("cold sink") and reduced risk of ureteral stricture.

Aside from ablation and partial nephrectomy, active surveillance is an option supported by the observation that most small RCCs are indolent. Although Larcher et al showed that tumour ablation was associated with significant protective effect on cancer-specific mortality compared to surveillance,[14] it can be argued that elderly patients may be more likely to die from other comorbidities than stage 1a RCC. Separately, in cases of patients with residual tumour after thermal ablation, active surveillance has been recently proposed as an acceptable alternative with delayed intervention in those with high tumour volume doubling time.[15]

Small patient numbers is a major limitation that may have prevented us from detecting any significant relationship between tumour factors and ablation efficacy (type II error). Future studies of a larger cohort will be useful to further aid our clinical decision-making.

Conclusion

We advocate due consideration for RFA of small renal tumours amongst elderly patients with significant comorbidities and/or poor renal function. Our experience

has reinforced the need to counsel patients on the intent of RFA (curative, palliative or debulking), its limitations in larger and central tumours and the attendant likelihood of requiring multiple ablation sessions to achieve complete tumour eradication.

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