Percutaneous Radiofrequency Ablation: A Novel Approach to Renal Cell Carcinoma

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Introduction

I. Renal Cell Carcinoma

II. Patient J.F.

III. Percutaneous Radio-frequency Ablation
Epidemiology

- Neoplasm of the renal tubular epithelial cells also known as Hypernephroma, Adenocarcinoma of the kidney and the “internist’s tumor”.

- Constitutes 2-3% of all cancers and 80-85% of adult primary renal malignancies.

- Occurs primarily in the sixth to eighth decades of life with a male:female predominance of 2:1.

- Affects more than 30,000 individuals per year in the United States with an annual worldwide mortality of 100,000.
The incidence of RCC has risen steadily since the mid-1970’s due largely to improved imaging modalities.
Pathogenesis

- Most cases of RCC are sporadic; molecular analysis frequently reveals chromosomal losses from 3p14 to 3p26.

- Risk factors: tobacco use, obesity, hypertension, unopposed estrogen therapy, and exposure to asbestos, cadmium and petroleum products.

- Autosomal dominant familial forms (4%): Von Hippel Lindau syndrome, Tuberous Sclerosis and Hereditary Clear Cell Carcinoma.
Clinical Presentation

• **Classic symptoms**: hematuria (50-60%), abdominal pain (40%) and a palpable mass (30-40%). Less than 10% of patients present with the “classic triad”.

• **Non-specific symptoms**: fevers, night sweats, malaise and weight loss.

• **Metastases-related symptoms**: lung (55%), bone (35%), liver (35%) and brain (5%).

• **Paraneoplastic syndromes**: erythrocytosis, hepatic dysfunction (Stauffer’s Syndrome), hypercalcemia and amyloidosis.
Renal Cell Carcinoma

Large exophytic tumor extending through the renal capsule

Pulmonary metastases from RCC

www.medinfo.ufl.edu

www.moffitt.usf.edu
Prognosis: Robson Staging

Five year survival:
• Stage I: 65-85%
• Stage II: 45-80%
• Stage III: 15-35%
• Stage IV: 0-10%

• 5 year mortality following diagnosis of RCC is over 50%.
Patient J.F.

- 5/01: J.F. is an 83 year-old male who presents to his primary care physician on complaining of right-sided flank pain for 1-2 months.
- PMH: hypertension, atrial fibrillation, and bilateral total knee replacements.
- Physical exam and routine blood work are within normal limits.
- Abdominal US at the outside hospital was inconclusive. J.F. is scheduled for an abdominal CT the following week.
5/01 Axial CT

1 x 1.2 cm wall-enhancing focal mass in the upper pole of the left kidney

Normal appearing right kidney
5/01 Coronal CT

The same nodular lesion seen on a coronal slice.
Renal Mass Evaluation

1) **Ultrasound**: Used for initial evaluation as simple cysts can be reliably identified:
   a) Anechoic
   b) Posterior enhancement
   c) Sharply demarcated wall

2) **CT with and without contrast**: Performed if lesion does not satisfy criteria for simple cyst. Further evaluated according to Bosniak criteria.

3) **MRI**: Obtained for poor CT characterization, IV contrast allergy or renal insufficiency.

4) **Aspiration**: Biopsy should be avoided due to risk of seeding needle tract with tumor.
Bosniak Classification

Criteria for the evaluation of renal cystic disease by CT:

I) Thin wall without septations, calcifications or enhancement
   = Simple cyst
II) Thin wall with few septations and/or calcifications
    = Likely a cyst
III) Thick wall with septations and calcifications. No enhancement
    = Unknown
IV) Thick wall with thick septations, coarse calcifications and enhancement
    = Likely a tumor
J.F.’s Renal Mass Evaluation

- 6/01: An US is obtained; however, the nodule is not visualized due to study limitations.
- 7/01: An MRI is recommended to further characterize the mass.
7/01 MRI—Unknown Nodule

Mass demonstrates wall enhancement with a hypointense center.
7/01 MRI—Simple Cyst

Non-enhancing, thin-walled 5mm nodule on the medial aspect of the upper pole
The mass deforming the renal contour
7/01 Coronal MRI

Enhancement of the solid mass with gadolinium
J.F.’s Mass Follow-up

- 7/01: A six month follow-up MRI is recommended to assess for change of the small, enhancing, poorly-characterized mass.

- 12/01: Repeat MRI reveals a stable appearance of the lesion without any new abnormalities. Six month follow-up is again recommended.

- 3/02: J.F presents with hematuria and an MRI study is obtained.
3/02 Coronal MRI

Slightly larger, uniformly enhancing, lesion

Normal appearing right kidney
3/02 Axial MRI

Mass in the upper pole of the left kidney
Management of RCC

- **Renal masses < 3cm**: watchful waiting with routine imaging follow-up.
- **Renal masses > 3cm**: radical nephrectomy, laparoscopic nephrectomy or partial nephrectomy.
- **Medical management**: chemotherapy and radiation therapy have little effect.
- **Experimental treatments**: in-situ ablation with high-intensity ultrasound, cryotherapy, laser and radiofrequency energy.
Radiofrequency Ablation

- Percutaneous Radiofrequency Interstitial Tissue Ablation is an FDA-approved, minimally invasive means of treating small, focal neoplasms with a needle electrode using CT- and/or US- guidance.

- RF energy generates ionic agitation and thermal energy, causing microvascular thrombosis and coagulative necrosis at temperatures greater than 50 degrees Celsius.
RF Ablation and Renal Cell CA

• Extensively utilized for the treatment of small primary and metastatic hepatic and bone tumors.


• 1999, McGovern et al: first successful use of the technique in-vivo on a patient with RCC.

• 2000, Gervais et al: short term efficacy of RCC ablation demonstrated by CT imaging follow-up in 8 patients.
RF Ablation Advantages

Potential advantages over surgical treatment:

• Increased efficacy
• Increased cost-effectiveness
• Decreased morbidity, including pain
• Decreased operating time
• Treatment on an out-patient basis
Ablation Device

• Needle electrode is connected to a generator which provides the RF energy source.

• Distal array of probes are deployed from the shaft to a maximum diameter of 3 cm.

• Temperature monitors at probe tips allow for heat monitoring.

• Shaft is insulated to protect normal tissues from damage.
RF Ablation Indications

- Localized tumors < 3 cm that exhibit growth over 1 year
- Poor surgical candidates
- Hereditary predisposition to develop multiple RCC’s.
- Solitary kidney
- Patients who refuse surgery
- Alternative to watchful waiting
J.F.’s Clinical Management

• Given that the nodule is < 3 cm and enhancing, and that J.F. is 83 years-old and with co-existing morbidities, the decision is made to treat with Percutaneous RF Ablation.

• 3/9/02: Under conscious sedation, RF ablation is administered via a 3 cm probe for a total of 20 minutes at 4 to 8 minute intervals at temperatures exceeding 60 degrees Celsius.
4/02 Pre-Ablation Ultrasound

1.3 cm hypoechoic region surrounded by hyperechoic cortex rim
4/02 CT-Guided Intervention

RF needle electrode in the left kidney
Patient #1: US-Guided Intervention

Hyper-echoic microbubbles forming at probe array

Needle electrode at center of tumor

J. Urology, January 2002
4/02 Post-Ablation CT

- Good enhancement of right kidney with contrast
- Hypo-attenuation of ablated pole of left kidney
J.F.’s Outcome

• The immediate post-ablation CT reveals adequate RF ablation coverage with clear margins.

• J.F. tolerates the procedure well and experiences no complications. The patient is discharged from the hospital on the same day.

• He is scheduled for CT follow-up in July 2002.
Patient #2:

Pre- and Post- RF CT

Pre-ablation: Hypo-attenuated posterior left renal tumor with heterogeneous enhancement

Post-ablation (4 months): Decreased size of non-enhancing lesion represents residual scar

J. Urology, May 2000
RF Limitations

1) **Size**: limited to RCC’s less than 3 cm secondary to:
   a) Hypervascularity
   b) Necrosed tissue accumulation

2) **Inadequate post-intervention imaging**: may require repeat visits for definitive treatment.

3) **Complications**: hemorrhage, infection, injury to adjacent organs and vessels, adverse reactions to anesthesia and tumor seeding along the needle tract.
Conclusion

• Recent studies have demonstrated Percutaneous RF Ablation to be a safe, effective and well-tolerated intervention for select RCC patients.

• Experience with this minimally invasive procedure is limited; however, encouraging preliminary results suggest that additional future research with extended follow-up is warranted.

• While surgery continues to be the standard of care for RCC, the appropriate clinical role for RF Ablation continues to evolve.
References

Atkins MB, Garnick MB. Epidemiology of Renal Cell Carcinoma. UpToDate.com 2002.


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