Image-guided percutaneous microwave ablation of small renal tumours: short- and mid-term outcomes

Romaric Loffroy, M.D, Ph.D
Professor of Radiology
Section Head of Interventional Radiology

Department of Vascular, Oncologic and Interventional Radiology
François-Mitterrand University Hospital
Dijon, France
Romaric Loffroy, M.D., Ph.D.

- Consultant/Advisory Board: WL Gore, Guerbet, GEM
- Speaker/Honoraria: WL Gore, Guerbet, GEM
Thermal ablative techniques

RFA  Cryoablation  MWA

European guidelines

Patients with small renal masses, with comorbidities unfit for surgery, and in patients with impaired renal function or with only a functional kidney

Background

• MWA is based on electromagnetic waves emitted by a microwave generator

• Electromagnetic microwaves agitate water molecules of the tissue, which leads to protein denaturation, cell membrane disruption, and finally coagulation necrosis with cellular death

• MWA has several theoretical advantages over other available techniques:
  – Higher and homogeneous heating temperature
  – Faster procedure
  – Greater volume of tumour ablation and more complete destruction of tumours close to blood vessels due to reduced cooling

• Nevertheless, there are only few series currently available in the literature reporting the efficiency of this technique
Purpose

- To evaluate the efficacy, complications and mid-term results of MWA for inoperable patients with small renal tumours

- Given that MWA was a common practice, the local ethics committee did not request additional consent
Patients (1)

• Retrospective study
• Between August 2012 and February 2015
• 29 tumours were treated in 23 patients
  – 1 in 20 patients, 2 in 1 patient, 3 in 1 patient, 4 in 1 patient
• T1N0M0 malignant renal tumours < 5 cm
• Disqualified from surgery
  – Advanced age ≥75 years (14)
  – Synchronous cancer in another organ during treatment (14)
  – Bilateral or multiple tumours (3)
  – Von Hippel Lindau disease (2)
  – Recurrence after partial nephrectomy (1)
  – Recurrence on solitary kidney after contralateral total nephrectomy (1)
  – Kidney transplant (1)
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Average (range, SD) or proportion [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>75 (55-90; ±9.7)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>17 [74]</td>
</tr>
<tr>
<td>Women</td>
<td>6 [26]</td>
</tr>
<tr>
<td>Tumour size (cm)</td>
<td>2.7 (1-4.7; ±1.3)</td>
</tr>
<tr>
<td>Tumour stage</td>
<td></td>
</tr>
<tr>
<td>T1a</td>
<td>17 [79]</td>
</tr>
<tr>
<td>T1b</td>
<td>6 [21]</td>
</tr>
<tr>
<td>Localization</td>
<td></td>
</tr>
<tr>
<td>Parenchymal</td>
<td>18 [62]</td>
</tr>
<tr>
<td>Exophytic</td>
<td>11 [38]</td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Solid</td>
<td>24 [83]</td>
</tr>
<tr>
<td>Cystic</td>
<td>5 [17]</td>
</tr>
</tbody>
</table>


*Quant Imaging Med Surg* 2015;5:649-55
Patients (2)

- Of 23 patients:
  - 4 were on dialysis for chronic terminal kidney disease (CKD)
  - 7 were moderate CKD [glomerular filtration rate (GFR) estimated between 30-60 mL/min]

- Only 8 patients underwent a biopsy prior to the ablathermy, that confirmed the diagnosis of RCC in all cases

- The other patients had either typical imaging findings with cystic lesions characterized as Bosniak IV or a marked evolution between two successive examinations
MWA procedure

- MTA Acculis® (AngioDynamics, NY, USA)
  - Microwave generator: delivers a power of 60 to 140 W at an operating frequency of 2.45 GHz
  - Control station: allows temperature monitoring during the ablation
  - Applicators or antennas with integrated cooling system: 14, 19 or 29 cm, for a diameter of 15 Gauges

- General anaesthesia
- CT or US guidance + systematic CT control
- Ablation volume and ablathermy duration defined prior to the procedure according to manufacturer’s instructions
- Hydrodissection technique used in 5 patients with tumours close to the colon
- Discharge the day after the treatment
Follow-up

- MRI follow-up at 2 months, 6 months, 1 year and annually for 5 years when no recurrence was detected

- Usual clinical oncology follow-up by the urologist

- 1 patient was followed by CT of the abdomen and pelvis with contrast medium injection, because of a pacemaker placement 6 months after thermal ablation

- The MRI protocol was standardized
  - Haste axial and coronal T2-weighted fast sequences
  - Diffusion sequences
  - Fat-sat turbo spin echo (TSE) T1-weighted sequences without and with intravenous injection of gadolinium with contrast-enhanced dynamic study and subtractions
Endpoints

• Primary endpoint: technical efficiency defined by the absence of residual vascularized tumour on MRI control performed 2 months after treatment

• Clinical success corresponded to the absence of tumour recurrence at the following MRI beyond 2 months

• Complications were classified as minor or major according to the Society of Interventional Radiology (SIR)
Results

- Technical efficiency of 96% with 1 procedure by tumour sufficient
- Duration ≤6 min per tumour
- Mean follow-up of 12.2±6.6 months (0-25 months)
  - No locoregional or distant recurrence
  - Clinical success rate of 100%
- Average length of hospitalization: 2.2±1 days (1-5 days)
- 1 major complication (4%)
  - Hypertensive crisis leading to an acute pulmonary oedema complicated by cardiogenic shock and death
- 3 minor complications (13%)
  - 1 perirenal hematoma, 1 perirenal urinoma, 1 fracture of the tip of the applicator
- No significant changes in renal function (creatinine levels) before treatment and at day 1 after treatment ($P=0.57$)
The recurrence-free survival rate was 78%
Advantages of MWA

- **Active heating process**
  - Produces higher temperatures than the passive heating of RFA and should allow for more complete thermal ablation in a shorter period of time

- **Higher temperatures (greater than 100° C) and lower sensitivity to local variation in tissue physical properties**
  - Can overcome the “heat sink” effect: complete tumoral ablation

- **No electrical current flow through patients**
  - No risk of skin burns

- **Can be completed in less time than RFA**
  - Multiple antennas can be used simultaneously

_Sommer CM et al. J Vasc Interv Radiol 2013;24:1241-8_
Comparison with other techniques

Meta-analysis of cryoablation versus microwave ablation for small renal masses: is there a difference in outcome?

Table 2. Patients, tumor characteristics, and outcome according to ablation modality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cryoablation</th>
<th>n (%)</th>
<th>Microwave ablation</th>
<th>n (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of series</td>
<td>44</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of patients</td>
<td>2989</td>
<td>-</td>
<td>164</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of lesions</td>
<td>3786</td>
<td>2989 (100)</td>
<td>164</td>
<td>164 (100)</td>
<td>-</td>
</tr>
<tr>
<td>Age (years)</td>
<td>66.9±4.82</td>
<td>2885 (96.52)</td>
<td>58.81±14.38</td>
<td>164 (100)</td>
<td>0.15</td>
</tr>
<tr>
<td>Tumor size (cm)</td>
<td>2.58±0.38</td>
<td>2793 (93.44)</td>
<td>3.13±0.81</td>
<td>164 (100)</td>
<td>0.04</td>
</tr>
<tr>
<td>Duration of follow-up (months)</td>
<td>30.22±14.04</td>
<td>2989 (100)</td>
<td>17.86±7.93</td>
<td>164 (100)</td>
<td>0.07</td>
</tr>
<tr>
<td>Primary effectiveness (%)</td>
<td>93.75±17.02</td>
<td>2625 (87.82)</td>
<td>91.28±13.22</td>
<td>164 (100)</td>
<td>0.41</td>
</tr>
<tr>
<td>Cancer-specific survival (%)</td>
<td>98.27±1.33</td>
<td>1008 (33.72)</td>
<td>96.80±0.00</td>
<td>106 (64.3)</td>
<td>0.48</td>
</tr>
<tr>
<td>Local tumor progression (%)</td>
<td>4.08±1.56</td>
<td>1887 (63.13)</td>
<td>2.54±1.62</td>
<td>154 (93.90)</td>
<td>0.46</td>
</tr>
<tr>
<td>Progression to metastatic disease (%)</td>
<td>0.80±0.81</td>
<td>1544 (51.65)</td>
<td>0.00±0.00</td>
<td>164 (100)</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Unless otherwise specified, data are given as mean±standard deviation.
Interest of MRI follow-up ++

- CE dynamic T1-w sequences with subtractions
Conclusion

- **MWA** technique appeared to be an effective and safe therapeutic alternative for the treatment of localized small exophytic and parenchymal renal tumours in non-operable patients.

- **Benefits**
  - Higher intratumoral temperatures
  - Larger tumor ablation volumes
  - Faster ablation times
  - Ability to use multiple applicators simultaneously
  - Optimal heating of cystic masses and tumors close to the vessels
  - Less procedural pain?

- RCT would be needed

- New developments with predictable spherical ablation zone