Case Series of the Month

Laparoscopic Microwave Ablation and Enucleation of Small Renal Masses: Preliminary Experience

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1. Case report

1.1. Materials and methods

From November 2008 to October 2010, we selected 10 male patients (without major comorbidities) affected with incidental small renal masses (SRMs) for laparoscopic-assisted microwave (MW) tumour ablation and enucleation. Our purpose was to assess the efficacy of thermoablative MW effects on SRMs as well as the haemostatic and necrotic MW effects on the parenchyma surrounding the neoplasm.

Inclusion criteria were tumour size <5 cm, clinical stage T1 N0 M0, exophytic cancer, and distance >1 cm from the hilar renal vessels and urinary collecting system (Fig. 1). Mean age was 66 yr (range: 46–84 yr). Mean renal tumour diameter was 2.75 cm (range: 1.3–4.2 cm). MW antennas were applied one to three times depending on tumour volume, location, and shape. After MW thermoablation, laparoscopic enucleation was performed to evaluate the histopathologic and haemostatic effects of MW.

The mean MW antenna application time was 14.1 min (range: 4–30 min). Enucleation did not require renal pedicle clamping in any of the cases because no significant bleeding took place. Preablation pathology revealed clear cell renal carcinoma of Fuhrman grade I–II in all cases. Postablation pathology showed extensive coagulative necrosis without skipped tumour areas. No intra- or postoperative complications were reported.

Histopathologic effects on SRMs provide consistent proof of principle for future studies.

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Epidemiology Collaboration formula), and thoracoabdominal computed tomography (CT) scan. Blood chemistry and eGFR were repeated 1 mo postoperatively. Table 1 lists the patient and tumour characteristics. All patients had been informed about the alternative options (mini-invasive procedures/active surveillance), but they all chose surgery. All patients were required to sign an informed consent approved by the local ethics committee.

Patients were placed in the flank position. A classic transperitoneal three- to four-trocar laparoscopic approach was used. After retracting the mesocolon, the renal fascia was opened, the renal artery was identified and suspended, and the tumour along with the surrounding area was defatted. A preablation Tru-Cut biopsy of the tumour was performed.

Laparoscopic MW tumour ablation was performed through a 13-gauge antenna (with a 2-cm noninsulated MW-emitting tip) connected to an Evident Valleylab generator (Covidien, Mansfield, MA, USA) able to produce 45 W of power at 915 MHz. The ablative lesion has the volume of a prolate spheroid, whose major semiaxis corresponds to the length of the emitting tip. The same antenna was applied one to three times depending on tumour volume, location, and shape to obtain the best ablative effect (Fig. 2). The usual application time was 10 min. In two cases the application was shorter (4 min and 7 min, respectively) because of small tumour size and the tissue modifications (color change) observed during the treatment.

After MW thermoablation, laparoscopic enucleation without hilar clamping was performed in all cases to evaluate the MW histopathologic and haemostatic effect. Biopsy of the parenchyma surrounding the neoplasm was also performed. Histopathologic analysis of preablation tumour Tru-Cut biopsies and of postablation specimens (enucleated SRMs and biopsies of the surrounding parenchyma) were based on both standard haematoxylin–eosin and reduced nicotinamide adenine dinucleotide diaphorase staining.

### 1.2. Results

Mean operating time was 128.5 min (range: 70–210 min). Mean application time of the MW antenna was 14.1 min (range: 4–30 min). Intraoperative renal pedicle clamping was not required in any of the cases because no significant

### Table 1 – Patient and tumour characteristics

<table>
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<th>Patient</th>
<th>Age, yr</th>
<th>Follow up, mo</th>
<th>Tumour size, cm</th>
<th>Side</th>
<th>Preablation histology</th>
<th>Fuhrman grading</th>
<th>Operative time, min</th>
<th>Ablation time, min</th>
<th>Preoperative creatinine, mg/dl</th>
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CKD-EPI = Chronic Kidney Disease Epidemiology Collaboration (formula); NA = not applicable.
bleeding took place. A haemostatic agent (TachoSil or FloSeal) was applied to stop minimal residual bleeding when necessary, but in no cases were haemostatic sutures required. Mean blood loss was 60 ml (range: 30–100 ml). Preablation pathology reported clear cell renal carcinoma with a Fuhrman grade of I–II in all cases (Fig. 3). Postablation pathology showed extensive coagulative necrosis (with maximum effects close to the antenna site) without skipped tumour areas (Fig. 4a–4c). Nicotinamide adenine dinucleotide diaphorase staining showed high staining in the preablation tumour biopsies (viable tissue) and no significant staining in the postablation SRM specimens, indicating a uniform cell death in the ablation zone. In all cases histopathologic diagnosis was based on preablation pathology because complete postablation necrosis made it difficult to interpret the treated specimens. Postablation biopsies of the surrounding parenchyma showed 1–2 mm of necrotic tissue and normal renal tissue underneath.

Drains were removed within 3 d, and patients were discharged the day after. No intra- or postoperative complications, including bleeding or anaemia, were reported. No deterioration in renal function was noted.

After a mean follow-up of 13 mo (range: 1–25 mo; follow-up of patients 1–9 >3 mo), no recurrence was detected by thoracoabdominal CT scan performed 3 mo postoperatively and then every 6 mo.

2. Discussion

Although nephron-sparing surgery still represents the treatment of choice for SRMs < 5 cm, it also remains a challenge for the surgeon because of the risk of intra- or postoperative bleeding. The development of laparoscopic partial nephrectomy is still limited by the difficulties of haemostasis.

Alternative local ablative techniques recently have been considered as nephron-sparing treatment for SRMs; for example, patients with a solitary kidney or borderline renal function are increasingly treated with ablation techniques [1].
In addition to the more well-known ablative techniques such as radiofrequency and cryotherapy, more recently new energy generators such as high-intensity focused ultrasound and MW have been proposed [2]. By virtue of its thermoablative effect, MW causes coagulative cell necrosis by inducing the friction of water molecules. The theoretical advantages of MW tumour ablation are the higher intratumoural temperatures and higher tissue ablation volumes associated with a shorter operative cycle [3].

MW ablation has been applied to liver, lung, kidney, and, more rarely, to bone, pancreas, and adrenal glands with good results [3]. Most of the studies on MW renal cancer ablation are based on percutaneous applications and consequently not supported by histopathologic examination of the treated tumour [3–5]. Some preclinical studies have been published to evaluate morphology, size, and histologic features of the ablated areas in animal renal cancer [6–8]. Different protocols of time and power of ablation have been proposed [3]. An experimental study on porcine renal cancer recommended the application of 45 W for 10 min [8]. Clark et al [9] performed a phase 1 clinical trial to assess the histologic efficacy of MW ablation. Ten patients with renal tumours underwent either laparoscopic or open MW ablation with 60 W for 10 min followed by nephrectomy. The size of the ablated tissue was $41 \times 27 \times 22$ mm with a single probe and $57 \times 47 \times 38$ mm with a three-probe array. No viable cell was detected inside the ablation area at histopathologic examination, but no cell death was found beyond the ablation area. These findings are very interesting because in the kidney it is important to spare the healthy parenchyma as well as the vessels and urinary collecting system.

MW technology has already been applied to partial nephrectomy, especially in Japan [10], to reduce intraoperative bleeding: In these studies a MW tissue coagulator is used not for tumour ablation but is applied peripherally in the healthy parenchyma surrounding the cancer with circumferential punctures producing coagulation of a conical-shaped portion of tissue. Subsequently, a wedge resection is performed.

In our technique of MW tumour ablation, in contrast, the antenna is inserted into the tumour, thus allowing destruction of the tumour alone. Consequently, we can perform tumour enucleation instead of a wedge resection, thus sparing the surrounding healthy parenchyma as much as possible.

To our knowledge, the present study represents the first preliminary experience of laparoscopic MW tumour ablation combined with enucleation. Our purpose was to check MW thermoablative as well as haemostatic efficacy. Our histologic findings seem to confirm those reported by Clark et al [9]: complete coagulative necrosis within the ablation area and minimal damage outside the visually observed ablation zone. From this perspective, laparoscopy-guided MW application is important because it allows the surgeon to see in real time the tissue modifications (color change) during the treatment. Our experience regarding haemostasis showed very good results: Intraoperative bleeding was not significant during MW application.

In conclusion, MW treatment provides optimal haemostasis, making laparoscopic renal tumour enucleation easier and possible without renal pedicle clamping and haemostatic sutures. Histopathologic effects on SRMs provide consistent proof of principle for future studies. Additional studies on larger series of patients with longer follow-up are needed to confirm our results.

**Conflicts of interest:** The authors have nothing to disclose.

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**EU-ACME question**

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**Question:** Nephron-sparing surgery represents the treatment of choice for renal cancers:

A. <5 cm
B. 5–7 cm
C. >7 cm
D. Of papillary type

**References**