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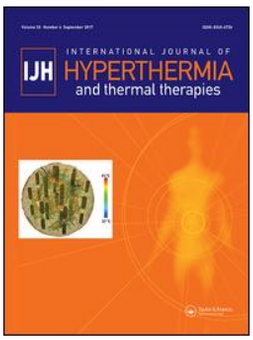

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Percutaneous microwave ablation of renal cell carcinoma: practice guidelines of the ultrasound committee of Chinese medical association, interventional oncology committee of Chinese research hospital association

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ABSTRACT

Imaging-guided percutaneous microwave ablation (MWA) with high thermal efficiency comprises rapid, successful management of small renal cell carcinomas (RCCs) in selected patients. Ultrasound Committee of Chinese Medical Association, Interventional Oncology Committee of Chinese Research Hospital Association developed evidence-based guidelines for MWA of RCCs after systematically reviewing the 1969–2019 literature. Systematic reviews, meta-analyses, randomized controlled trials, cohort, and case–control studies reporting MWA of RCCs were included and levels of evidence assessed. Altogether, 146 articles were identified, of which 35 reported percutaneous MWA for T1a RCCs and 5 articles for T1b RCCs. Guidelines were established based on indications, techniques, safety, and effectiveness of MWA for RCCs, with the goal of standardizing imaging-guided percutaneous MWA treatment of RCCs.

KEY POINTS

- Microwave ablation is recommended for managing small renal cell carcinoma in selected patients.
- Imaging protocols are tailored based on the procedural plan, guidance, and evaluation.
- Patient's selection evaluation, updated technique information, clinical efficacy, and complications are recommended to standardize management.
- A joint task force (multidisciplinary team) summarized the key elements of the standardized report.

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Guidelines; microwave ablation; renal cell carcinoma; imaging; percutaneous

Introduction

Kidney cancer is currently the ninth most common cancer in men and the 14th most common in women worldwide [1]. Renal cell carcinoma (RCC) comprises more than 90% of kidney cancer, with clear cell (70%), papillary (10–15%), and chromophobe (5%) carcinoma the main histologic types [2]. Several different locoregional therapies for RCC have been performed, mainly including open nephrectomy, laparoscopic nephrectomy, thermal ablation, and radiotherapy [2–5]. Imaging-guided percutaneous ablation has been successfully applied for management of small RCC in selected patients, owing to its advantages of minimal invasion, favorable efficacy, and reproducibility [6–11]. The most widely used thermal ablative techniques for RCC are cryoablation, radiofrequency ablation (RFA), and microwave ablation (MWA) [9–11]. MWA offers many benefits of other ablation techniques with higher intratumoral temperatures, larger tumor ablation volumes, faster ablation times, the ability to use multiple applicators simultaneously, and less dependent on electrical conductivities of tissue. MWA was first adopted in RCC treatment by Dupuy et al. [12] in 2005. They reported the patient was performed percutaneous MWA under computed tomography (CT) guidance. MWA was firstly reported under ultrasound [5] guidance by Liang et al. [13] in 2008 and it is the first report with survival and recurrence result with series cases. After that, MWA of RCC has achieved rapid

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Supplemental data for this article can be accessed here.

development by percutaneous, open or laparoscopic approach in China and worldwide over the past decade [14–16]. Several studies have shown that the local tumor control, complications, and long-term survival were equivalent between MWA and cryoablation, RFA or nephrectomy in treatment of T1a RCC [17–20].

Among several MWA techniques, percutaneous MWA shares the advantage of precise positioning with image guidance and minimal invasion, and percutaneous MWA achieved wide application compared with open or laparoscopic approach. Therefore, Ultrasound Committee of Chinese Medical Association, Interventional Oncology Committee of Chinese Research Hospital Association RCC ablation Guideline Panel has compiled these clinical guidelines to provide clinicians with evidence-based information and recommendations for image-guided percutaneous MWA of patients with RCC. The guideline panel is a multidisciplinary group consisting of clinicians with particular expertise in MWA of RCC. To meet the requirements for a multidisciplinary approach, the panel has been reinforced by several other experts, including urologists, medical oncologists, pathologists, radiologists, and biostatisticians. The guideline was established in accordance with the basic principles of evidence-based medicine and the clinical practices on MWA of RCC, and by referring to the USA NCCN Clinical Practice Guidelines in Oncology-Kidney Cancer [6], the European Association of Urology (EAU) Guidelines on RCC [7], and European Society For Medical Oncology [8] Clinical Practice Guidelines on RCC [8].

Evidence acquisition

Systematic reviews of the literature were conducted in accordance with PRISMA guidelines [17]. For each literature, elements for inclusion and exclusion, including patient population, intervention, comparison, outcomes, study design, and search terms and restrictions, were developed using an iterative process involving all members of the expert panel to achieve consensus. English-language literature searches were conducted separately using the following databases: Medline, Medline In-Process, Embase, Cochrane Library, Scoups, trial registries, and ISI Web of Science from 1 January 1969 up to 31 September 2019. The search strategy was shown in Supplementary Appendix 1. The search identified a total of 146 articles. Among them, 40 studies reporting percutaneous MWA procedures in 2129 RCC tumors were eligible for inclusion (Figure 1).

Description of MWA

As one of the energy-based ablation techniques, MWA refers to application of electromagnetic methods with frequencies $\geq$ 900 MHz to eradicate focal tumors [12]. The rotation of dipole molecules generates most of the heat during MWA [18–21]. Thus heat producing from friction induces cellular death *via* coagulation necrosis (Supplementary Appendix 2). Microwaves can deliver over a target volume continuously and may produce heating at any water and tissue content. The fast heating of microwaves may overcome the negative effects of rich perfusion of kidney and large ablation area with the use of microwave energy can be achieved [15, 16]. Two kinds of frequencies: 915 and 2450 MHz can be used for MWA. For T1a RCC treatment, only frequency of 2450 MHz is recommended to be adopted, and for larger RCC, a frequency of 915 MHz can be used in selected patients with safe tumor location for its advantage of larger ablation zones [22,23].

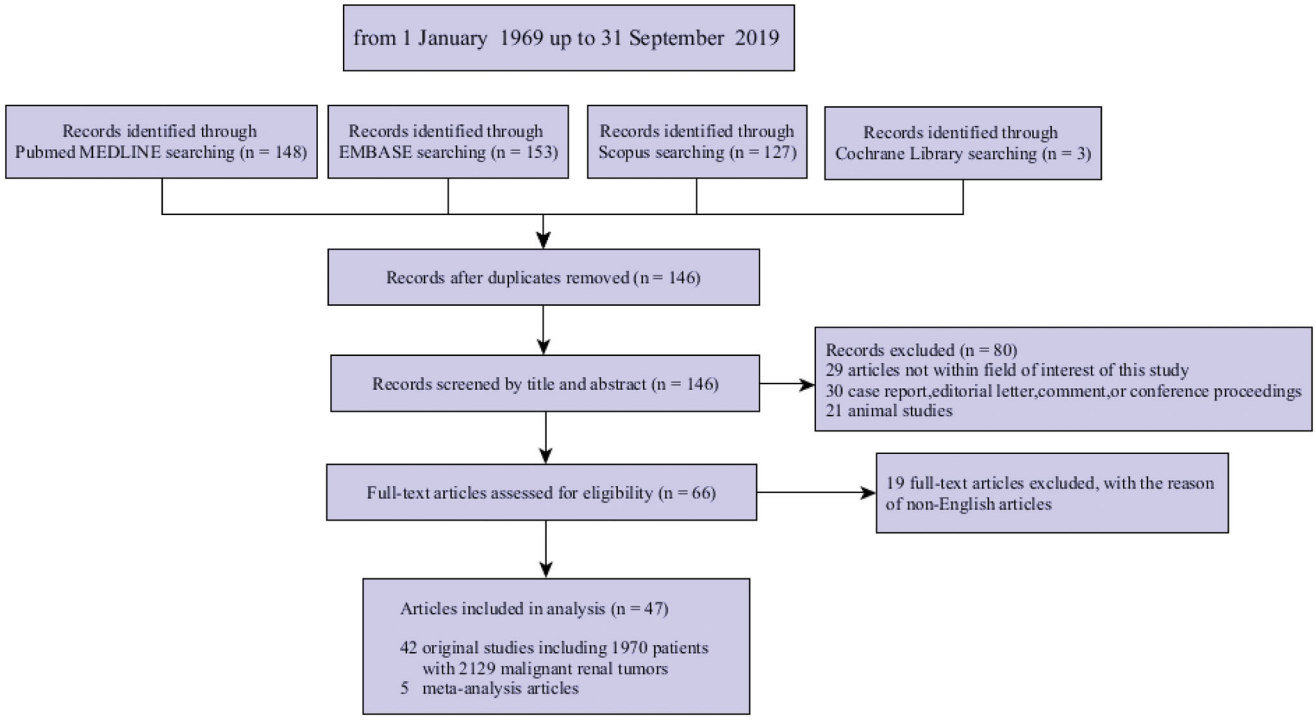

Figure 1. Flow diagram outlining article selection process.

There are more than 10 branded microwave systems available currently worldwide. All MWA systems are composed of three basic elements: microwave generator, low-loss flexible coaxial cable and antenna. The design of the antenna has focused mainly on needlelike, cooled-shaft, coaxial-based interstitial antennae [24–26]. Only one microwave machine (Kangyou Medical, Nanjing, China) is equipped with a thermal monitoring system with a separate temperature probe that can continuously measure temperature in real time during ablation [27,28].

Definitions of MWA

Therapeutic effect index including technical success, technical efficacy, complications, residual tumor, local tumor progression (LTP), LTP-free survival, metastasis-free survival (MFS), disease-free survival (DFS), cancer-specific survival (CSS), and overall survival (OS) is introduced in Supplementary Appendix 3 [29–32].

Ancillary procedures are those techniques that are used to separate critical non-target structures from the target ablation zone to avoid non-target thermal injury. That mainly includes hydro-dissection technique and indwelling double J tube in the ureter as an endo-sent technique.

Treatment guidance image

Image is of paramount importance for percutaneous ablation not only for clinical diagnosis and staging of RCC but also procedure planning and even evaluation of ablation effect. The feasibility of the MWA, the site of access, the number and the pathway of the antennae, the necessity of ancillary procedures need to be defined from pre-procedural image [32]. For US guided ablation, three kinds of images are necessary including US, contrast-enhanced US, and either contrast-enhanced CT or magnetic resonance imaging (MRI). For the limited sensitivity of US modality for the detection of small RCCs [33], the use of micro-bubble contrast and MRI/CT may increase the diagnostic accuracy of US and explicit the relationship between the lesion with the adjacent organs [34–36]. For CT guided ablation, contrast-enhanced CT is necessary for ablation planning and probe guidance, if the renal function of the patient permitted. Otherwise plain CT scan combined with noncontrast-enhanced MRI sequences such as diffusion-weighted imaging (DWI) or arterial spin labeling (ASL) is necessary [32].

Diagnosis

Pathological diagnosis is necessary for RCC patients. If the patients need to undergo biopsy to achieve pathological diagnosis, it is preferred to perform intraoperative tumor biopsy using a coaxial system before ablation to offer the opportunity to ablate the biopsy tract to decrease seeding and bleeding. There is consensus to biopsy with an 18-gauge core needle as a sufficient tissue sample is provided with acceptable morbidity [37] (Supplementary Appendix 4).

Indications and contraindications

The main indications and contraindications for percutaneous MWA of RCC are summarized in Table 1 (Supplementary Appendix 5). For patients with T1a RCC based on the American Joint Committee on Cancer (AJCC) [38], MWA should be considered as curative therapy.

Patient preparation and data required

Patients considered for MWA should be accurately evaluated through clinical history, physical examination, laboratory values and performance status. No specific sign is seen in patients with early-stage RCC. Signs may occur in less than 10% of RCC patients [39] including abdominal palpable mass, lower extremity edema, and hematuria. The main laboratory test items include renal function, serum liver enzymes and electrolytes, routine blood test, routine urinalysis, and test for blood coagulation. Urine cytology should be

Table 1. Indications and check list for MWA of RCC.

Indications		
Curative ablation	Cytoreductive ablation	Check List
• A single lesion with a diameter $\leq$ 4 cm(T1a) • A maximum of 3 lesions • Absence of renal vein cancerous thrombus • No extrarenal spread	• lesion $>$ 4 cm in diameter (including T1b and part of T2a stage RCC) • $>$ 3 lesions • Suffering from a small extrarenal tumor burden but absence of renal vein embolus • Recurrent renal cancer or unsuitable for other modalities	• histocytologic diagnosis • For US guidance, US + CEUS + contrast enhanced CT/MRI scan of nodule and kidney (lesion number, size, blood, location and renal venous thrombosis) before ablation; for CT/MRI guidance, only contrast enhanced CT/MRI scan needed • Chest X-ray and ECG for common pre-ablation examination • Chest CT, cerebral MRI/CT, radionuclide bone scan, and PET-CT being considered to confirm distant metastasis if necessary • Laboratory tests (routine, coagulation function, serum renal function and liver enzymes)
• Patients with ASA score 1–3 or ECOG 0–2 • Prothrombin time $<$ 25 s, prothrombin activity $>$ 40%, and platelet count $>$ 40 cells $\times$ 10^9/L • Bilateral renal cancer; renal cancer in solitary kidney; single functioning kidney; moderately or severely impaired renal function; Presence of comorbidities that would increase the risk the surgical intervention; patient's choice not to undergo resection		
Contraindications		
• Severe blood coagulation dysfunction • Tumor extending into major veins or high extrarenal tumor burden • Acute or active inflammatory and infectious lesions in any organ • Acute or severe chronic liver failure, pulmonary insufficiency or heart dysfunction		

MWA: microwave ablation; US: ultrasound; CEUS: contrast-enhanced ultrasound; CT: computed tomography; MRI: magnetic resonance imaging; RCC: renal cell carcinoma; ECG: electrocardiograph; PET: positron-emission tomography; ASA: American Society of Anesthesiologists; ECOG: Eastern Cooperative Oncology Group.

performed for patients with renal tumors adjacent to or involving renal pelvis. Radionuclide renography should be performed in patients with solitary renal tumor, bilateral renal tumor, abnormal renal function indicators. A full pre-ablation imaging work-up (a combination of contrast-enhanced imaging including US, CT, or MRI) should be performed to stage, locate the lesions, and exclude renal venous thrombosis and metastases accurately (Table 1). Chest X-ray and electrocardiogram are the common approaches for pre-operative examination in RCC patients. Chest CT, cerebral MRI/CT, radionuclide bone scan, and PET-CT may be considered with a need to confirm whether there is any distant metastasis.

Techniques

The guidance image is performed to choose the safest intercostal or subcostal needle access before MWA. If the patient is not contraindicated, general anesthesia is recommended. After the anesthesia, the antenna is placed into the chosen area of the tumor. The shortest path between the skin and the target is selected while avoiding puncture of other organs or vessels. In the multiple-needles procedure, two antennae directly connected to the MW generator are inserted into the tumor in parallel 1–2.5 cm apart. At each insertion, the tip of the needle is placed in the deepest part of the tumor. Multiple thermal zones are created along the major axis of the needle antenna by simply withdrawing the antenna from the preceding thermal lesion, and reactivating the MW generator. If necessary, due to tumor size, multiple overlapping ablations are usually needed to cover the entire tumor with a safety margin. In general, the microwave energy application is suggested to set at 50–60 W for 5–10 min in a session. For tumors less than 2.0 cm, one antenna is preferred, and for tumors measuring 2.0 cm or greater, two antennae are preferred to be inserted simultaneously for multiple-channel MW equipment, otherwise, two or more insertions will be needed by one antenna for single-channel MW equipment.

The size of the ablation zone can be roughly judged by US and CT during the guided procedure and be precisely judged by contrast enhanced US and CT/MRI after MWA (Supplementary Appendix 6 and Figure 2).

Care after MWA

After the MWA, the patient undergoes recovery for 4–6 h of bed rest. Then the patients can be observed for 2–3 additional days and both contrast enhanced US and MRI/CT are performed to evaluate the ablation effect. If the images show incomplete ablation, the second session needs to be performed to ablate the residual tumor. There is no consensus on the use of antibiotics after the ablation procedure. According to the review of articles reporting RFA, cryoablation, and MWA of renal masses, potentially infectious complications occurred infrequently in 74/6952 patients (1.06%) [40]. Therefore, prophylactic antibiotics for routine T1a renal tumor ablation are not recommended, but for the diabetic patients, patients with a ureteric stent placed for pyeloperfusion, patients with multiple or large tumors or with tumor adjacent to intestine, prophylactic antibiotics is recommended to use [32]. Patients can be discharged from the hospital when their renal images show complete necrosis of tumor and they have no major complication or feel no severe pain.

Follow up

For $\leq$4 cm RCC, patients need be observed on an outpatient basis at 3 months post MWA. At the first visit, the level of pain, the ability to pass urine, the serum renal function index, and the presence of any hematuria are assessed, and the skin puncture point is examined. One of the contrast-enhanced images including US, CT, and MRI scan needs to be performed to evaluate the effect of ablation. If complete ablation is achieved, then routine contrast-enhanced image is repeated to monitor for recurrence or metastasis at 6-month intervals during the first year and then annually after MWA. If there is any suspicion of tumor residual or disease progression, a new ablation can be arranged if the patient meet the criterion. For $>$4 cm RCC, a follow-up principle is recommended as at 3, 6, and 12 months after MWA and then at 6-month intervals during the patient's lifetime. The ablation zone will shrink gradually and the margin of the ablated tissue may be replaced gradually by fat that evolves to form a crescent-like band or "halo" [41].

Effectiveness

There is an extensive evidence in the literatures from meta-analysis, cohort studies, and case series on the technical outcomes, the safety and the effectiveness of the use of MWA for the treatment of T1a RCCs [15,27,42–53] (Table 2). All the literatures reported the MWA of RCC under US or CT guidance. The majority therapeutic studies provided in this practice document meet the Levels of Evidence (LoE) 2–4, as suggested by the center for Evidence-Based Medicine [8,58], illustrated in Table 3. One systematic review for percutaneous MWA of T1a RCC with 13 papers since 2012 showed pooled technical success rate and technical efficacy rate were 97.3% and 97.6%, respectively. The meta-analytic pooled LTP was 2.1%. The 1-, 2-, 3-, and 5-year pooled CSS were 99.1%, 98.4%, 97.6%, and 96.9%, respectively, while the OS were 98.3%, 94.9%, 86.8%, and 81.9%. In terms of major complications, a 1.8% of meta-analytic pooled incidence was found (15). Study with the largest number of patients is reported in the single-center retrospective series from Liang et al. in China ([59], LoE 4). The authors included 185 patients with 192 sporadic T1a RCCs that were treated with US-guided percutaneous MWA. In the study, during the median followed up of 42 months, the overall occurrence of LTP was 3.2% per patient. The OS rates at 1, 3, and 5 years were 98.3%, 94.0%, and 86.3%, respectively. The largest sample report on CT-guided percutaneous MWA of RCC is from Wells et al. in USA ([51], LoE 4), which showed the LTP rate was 1% (1/100) and 3-year OS was 91%. By now four reports

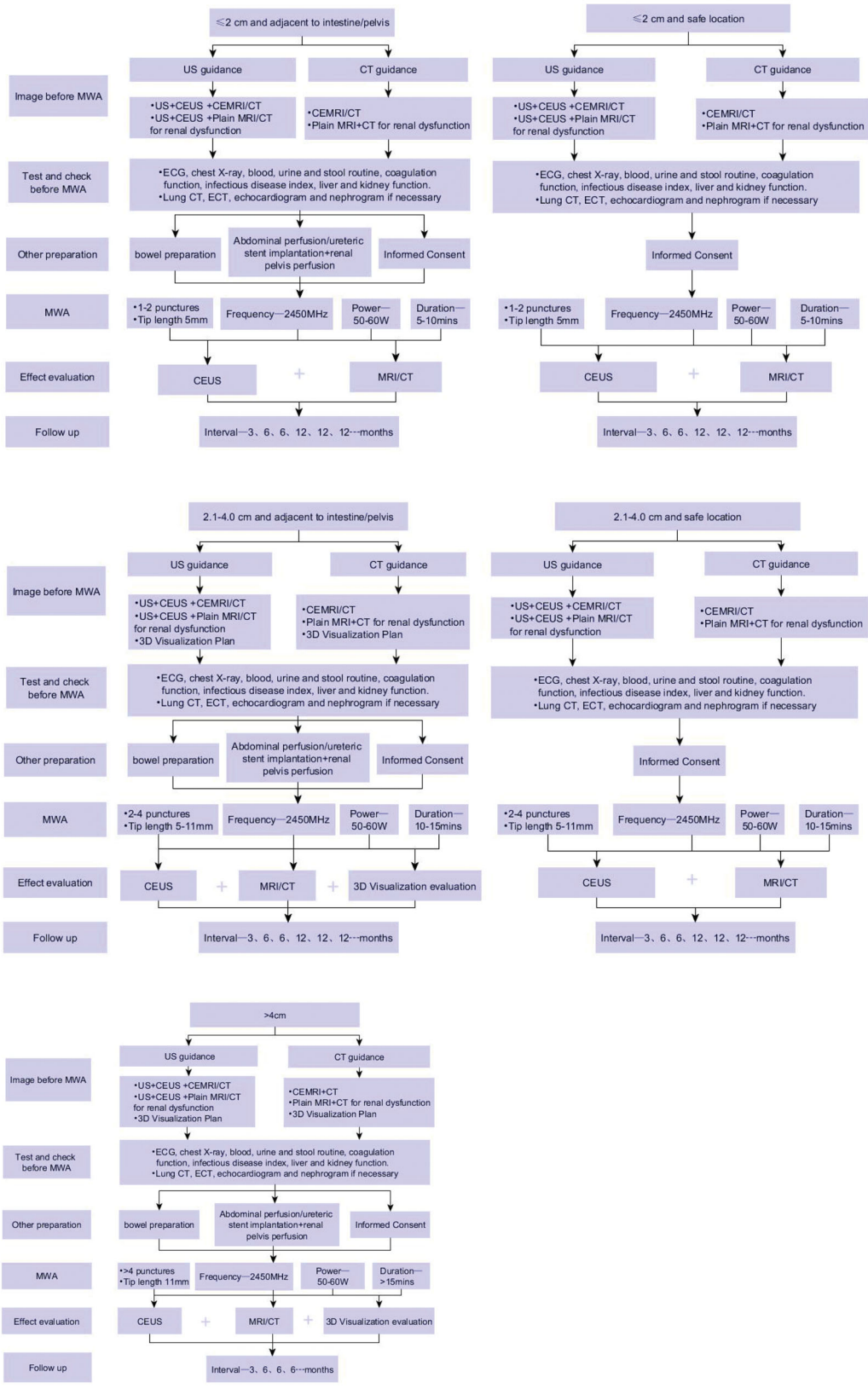

Figure 2. Flow diagram of technique procedure for microwave ablation of renal cell carcinoma with different size and location. MWA: microwave ablation; US: ultrasound; CEUS: contrast-enhanced ultrasound; CECT: contrast-enhanced computed tomography; CEMRI: contrast-enhanced magnetic resonance imaging; ECG: electrocardiograph; ECT: emission-computed tomography.

have compared surgery and MWA in RCC patients with comparative oncologic survival outcomes ([27,42,59,60], LoE 3). In addition, MWA has also been compared with cryoablation and RFA in treating small RCC from case control study. Three techniques achieved comparable treatment response and complication in T1a RCC, but MWA is associated with shorter treatment times and less sedation than RFA or cryoablation ([61,62], LoE 3). Two literatures reported the high power

Table 2. Major researches of MWA in RCC treatment (tumor number ≥ 50).

Author	Year and Country	Guidance imaging	Tumor number	Mean tumor size(cm)	Median follow-up (Mons)	CA (%)	LTP (%)	OS(%) 3-year 5-year	CSS(%) 3-year 5-year	Major complication(%)	Levels of evidence
Yu et al.[19]	2015 China	US	105	2.7 ± 0.9	25.8	100	1.0	93.3 82.6	97.0 97.0	1.7	3
Yu et al.[20]	2014 China	US	69	2.7 ± 0.9	20.3	100	1.5	89.7 67.3	97.1 97.1	2.5	3
Filippiadis DK et al.[48]	2017 Greece	CT	50	3.1	43	97.9	6.3	95.8 N/A	N/A	0	4
Chan et al. [52]	2017 France	CT	84	2.56	24	94	3.2	N/A	N/A	1.6	4
Ierardi et al. [53]	2017 Italy	US/CT	58	2.4 ± 0.9	25.7	100	15.7	N/A	N/A 96.5	3.4	4
Klapperich et al. [54]	2017 America	US/CT	100	2.6 ± 0.8	17	100	1	91 N/A	100 N/A	3.1	4
Dong et al. [54]	2016 China	US	105	2.9	25	94.3	6.9	N/A	N/A	2.9	4
Mu et al. [55]	2016 China	US	151	2.8 ± 0.8	36.4	100	7.1	94.8 89.5	N/A	3.6	4
Morel et al. [56]	2014 America	US/CT	55	2.6	8	100	0	N/A	N/A	0	4
Li et al. [57]	2013 China	US	83	3.2 ± 1.6	26	100	8.8	N/A	N/A	0	4
Hao et al. [58]	2018 China	US	171	2.6 ± 0.8	45.5	100	2.9	92.8 85.9	N/A	N/A	4

OS: overall survival; CSS: cancer-specific survival; CA: complete ablation; LTP: local tumor progression.

Table 3. Levels of evidence and grades of recommendation (adapted from the ESMO Clinical Practice Guidelines for RCC(8)).

Levels of evidence
- I. Evidence from at least one large randomized, controlled trial of good methodological quality (low potential for bias) or meta-analyses of well-conducted randomized trials without heterogeneity
- II. Small randomized trials or large randomized trials with a suspicion of bias (lower methodological quality) or meta-analyses of such trials or of trials
- III. Cohort studies
- IV. Case–control studies
- V. Studies without control group, case reports, experts opinions

Grades of recommendation
- A. Strong evidence for efficacy with a substantial clinical benefit, strongly
- B. Strong or moderate evidence for efficacy but with a limited clinical benefit, generally recommended
- C. Insufficient evidence for efficacy or benefit does not outweigh the risk or the disadvantages (adverse events, costs, etc.), optional
- D. Moderate evidence against efficacy or for adverse outcome, generally not
- E. Strong evidence against efficacy or for adverse outcome, never recommended

MWA for T1a RCC by using the equipment with the frequency of 915 MHz, but that induced a very high major complication rate of 11.5% and 20%, respectively ([63,64], LoE 4). Therefore, high-volume and high-power ablation is not recommended for T1 a RCC for the over large ablation zone.

The MWA for the treatment of RCC with T1b stage or more is with the aim of cytoreduction and symptom relief. MWA only achieves preliminary clinical application for reducing the tumor volume with an acceptable safety. The reports are very limited and the sample size is small [28,48,50,65,66]. It is difficult to obtain strong reference data in terms of complete ablation, tumor progression, long-term survival and complications with the LoE level 4.

Combined treatment with other modalities

The therapeutic efficacy of MWA can be augmented by other therapies. For patients with tumors adjacent to intestinal tract, renal pelvis and ureter, artificial ascites, intrapelvic saline perfusion, ureteral stent placement, and temperature monitoring with a separate temperature probe should be combined with MWA. Real-time virtual navigation system and three-dimensional visualization techniques provide an

Table 4. Complications during and after 1582 procedures of MWA of T1a RCC.

Clavien grade	*n* (incidence rate%)	Complication
I	43 (2.72)	Microscopic hematuria
	6 (0.38)	Gross hematuria
	7 (0.44)	Skin burn
	7 (0.44)	Flank pain or abdominal pain
	5 (0.32)	Thermal injury of psoas muscle
	25 (1.58)	Perirenal bleeding
	8 (0.51)	Urinoma
	1 (0.06)	Urinary fistula
	1 (0.06)	Thermal injury of pelvicalyceal system
II	3 (0.19)	Hepatic encephalopathy
	2 (0.13)	Perirenal bleeding
	2 (0.13)	Urinary fistula
IIIa	5 (0.32)	Symptomatic pleural effusion
	3 (0.19)	Injury to or stenosis of the ureter or ureteropelvic junction
	1 (0.06)	Abscess
	2 (0.13)	Urinary fistula
	1 (0.06)	Urinoma
	2 (0.13)	Perirenal bleeding
IIIb	1 (0.06)	Injury to or stenosis of the ureter or ureteropelvic junction
	2 (0.13)	Colon perforation
	1 (0.06)	Urinoma
	1 (0.06)	Abscess
IV	1 (0.06)	myocardial infarction
V	1 (0.06)	Stroke
	2 (0.13)	Death

appealing alternative option to be used in large or complex RCC ablation, enabling the physician to perform precise therapy to improve effectiveness ([65,67], LoE 4).

For patients in whom MWA cannot achieve complete necrosis, radiotherapy can be a useful supplement [8]. For palliation of local and symptomatic metastatic RCC disease or to prevent the progression of metastatic disease in critical sites, MWA can be combined with immuno- or targeted therapies [6–8].

Complication

The side effect of MWA of RCC mainly includes low-grade fever, pain, and transient hematuria, although occurring frequently, which rarely if ever result in substantial morbidity and do not require any further treatments. Major complication includes death related to procedure, uncontrollable bleeding, bowel perforation, abscess, ureteral stricture, urinary fistula, and tumor seeding, etc. (Table 4). After summarizing the total literatures on MWA of T1a RCC with 1582 procedures, the major complications (Clavien Grades III and V) of MWA of RCC are relatively low (Table 4 and Table S1). These can be controlled by surgical operation, interventional approach and medical therapy [49–52,68–71]. Based on the systematic literatures analysis of MWA for RCC in safety and effectiveness with the evaluation of evidence level, we performed a key recommendation on preparation, technique, and care during MWA procedure in patients with RCC (Table 5).

Table 5. Key recommendations on preparation, technique, and care during MWA procedure in patients with RCC.

Recommendation	GR
Contrast-enhanced multiphase abdominal MRI is recommended for work-up of patients with RCC and are considered important for both staging and diagnosis before ablation	A
Contrast-enhanced multiphase abdominal CT/US is the appropriate imaging modalities for renal tumor characterization and staging before ablation	B
A chest CT is recommended for staging assessment of the lungs and mediastinum for symptomatic patients before ablation	C
A bone scan is recommended for staging assessment for symptomatic patients before ablation	C
An abdominal B-mode US is recommended for staging assessment before ablation	B
A renal tumor biopsy is recommended before ablative therapy without previous pathology	A
A percutaneous renal tumor biopsy should be obtained with a coaxial technique	C
Use of the current TNM classification system is recommended	B
Grading systems and classification of RCC subtype should be used	B
Chest X-ray and ECG for common pre-ablation examination	A
Laboratory tests (routine, coagulation function, serum renal function and liver enzymes) for common pre-ablation examination	A
Ablation for tumors adjacent to renal pelvis, intestinal and pancreas	C
Cytoreductive ablation for >4 cm RCC without renal veins embolus or high extrarenal tumor burden	C
Fluid dissection technique for tumors adjacent to renal pelvis, intestinal and pancreas	A
Prophylactic antibiotics during the ablation procedure	C
US or CT as guidance imaging	A
MRI as guidance imaging	C
Three-dimensional navigation for ablation of complex tumors(dangerous location, large, unclear on US, etc)	B

GR: grade of recommendation; US: ultrasound; CT: computed tomography; MRI: magnetic resonance imaging; RCC: renal cell carcinoma.
A. Strong evidence for efficacy with a substantial clinical benefit, strongly.
B. Strong or moderate evidence for efficacy but with a limited clinical benefit, generally recommended.
C. Insufficient evidence for efficacy or benefit does not outweigh the risk or the disadvantages (adverse events, costs, etc.), optional.
D. Moderate evidence against efficacy or for adverse outcome, generally not.
E. Strong evidence against efficacy or for adverse outcome, never recommended.

Conclusion

Percutaneous MWA represents a valid treatment of T1a RCCs with excellent long-term technical and functional outcomes and a very low complication rate. Chinese panel has written and approved the guidelines to promote the cost-effective use of high-quality MWA therapeutic procedures for RCC. The guidelines will be updated when data or publications might change a prior recommendation or when the panel feels clarifications are required for the oncology community.

Author contributions

Dr Liang had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept *and* design: Liang and Yu Jie. Acquisition of data: Liang, Yu Jie, Dong, Yu Xiao-Ling, Cheng, Han, Yang, Guo, Liu, Wang, Hu, Dong, Pan and Sai. Analysis and interpretation of data: Liang, Yu Jie and Yu Xiao-ling. Drafting of the manuscript: Liang and Yu Jie. Critical revision of the manuscript for important intellectual content: Yu Jie and Liang

Disclosure statement

No potential conflict of interest was reported by the author(s).

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