Microwave thermotherapy for lung and kidney tumors

Clinical Policy ID: CCP.1528

Recent review date: 7/2024

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Policy contains: Image-guided thermal ablation, microwave ablation, non-small cell lung cancer, percutaneous ablation, renal cell carcinoma

Coverage policy

See also CCP.1397 Microwave thermotherapy for breast cancer.

Microwave thermotherapy (ablation) of a primary or metastatic lung tumor is clinically proven and, therefore, may be medically necessary when all of the following criteria are met (National Comprehensive Cancer Network, 2024b):

- The member either:
  - Is deemed medically inoperable due to the location or extent of the lesion or due to comorbid conditions.
  - Will not receive stereotactic ablative radiotherapy or definitive radiation therapy.
- A single tumor is less than or equal to 3 centimeters in size.

Microwave ablation of malignant kidney tumors is investigational/not clinically proven and, therefore, not medically necessary.

<u>Limitations</u>

No limitations were identified during the writing of this policy.

Alternative covered services

- Radiofrequency ablation.
- Cryoablation.
- Surgical resection.
- Stereotactic radiosurgery.
- Definitive radiation therapy.

Background

Tumor ablation is a minimally invasive technique that applies chemical or thermal methods under image guidance to induce cellular necrosis and destroy solid tumors while sparing adjacent tissue. Thermal ablation is accomplished by cooling or heating the targeted tissue to less than minus 40 degrees Celsius or more than 60 degrees Celsius, which will achieve cytotoxicity in most tissues. Depending on the technique, targeted tissues may be accessed percutaneously, laparoscopically, intraoperatively, endoscopically, or, in the case of high-intensity focused ultrasound, extracorporeally, to achieve locoregional tumor control (Gala, 2020).

Several minimally invasive thermal ablative modalities are available: radiofrequency, laser, cryoablation, high-intensity focused ultrasound, and microwave. Irreversible electroporation is a nonthermal option that applies short pulses of a strong electrical current to form permanent nanopores within the cell membrane to induce cell death. Radiofrequency is the most commonly used ablative modality for locoregional tumor eradication, but microwave ablation has emerged as an alternative (Gala, 2020).

Microwave systems comprise a microwave generator, a coaxial cable, and a 14 to 17-gauge antenna to transmit the waves to the tissue. Antenna (needle) placement is achieved using ultrasound, computed tomography, or fluoroscopic guidance, depending on lesion location. Total tumor necrosis can be achieved when temperature remains at 54 degrees Celsius for at least three minutes, or reaches 60 degrees Celsius instantly (Gala, 2020).

Both microwave and radiofrequency methods convert heat energy into coagulative necrosis of tumor cells. Unlike radiofrequency ablation, which uses electrical energy at a frequency of 3 hertz to 300 gigahertz, microwave ablation applies short-duration, high-voltage electromagnetic pulses with frequencies between 900 and 2,450 megahertz. Because of its larger electromagnetic field and rapid heating capabilities, microwave ablation creates a larger, homogenous ablative field and avoids the “heat sink” effect that commonly occurs with radiofrequency ablation of highly vascular solid organs. As a result, higher intratumoral temperatures and larger and predictable ablation zones can be created in a shorter time period. In addition, microwave ablation is not limited by the poor electrical conductivity and thermal conduction of charred or desiccated lung tissue, which can reduce the effectiveness of radiofrequency ablation (Gala, 2020).

For assessing response to locoregional treatment, computed tomography and magnetic resonance imaging are used at regular intervals. The optimal imaging modality for follow-up and imaging interpretation will depend on the therapy used and planned future treatments (American College of Radiology, 2018).

The U.S. Food and Drug Administration (2023) has issued 510(k) premarket approval to several microwave ablation devices as electrosurgical cutting and coagulation devices and accessories for soft tissue ablation.

Findings

Lung tumors

There is sufficient evidence from professional guidance, systematic reviews and meta-analyses of non-randomized studies, and two randomized studies described below to support the safety and efficacy of microwave ablation for treating malignant lung tumors. The advantages of image-guided tumor ablation methods compared to surgical treatment are faster recovery, reduced morbidity and mortality, accurate targeting under ultrasound or computed tomography guidance, and treatment in the outpatient setting.

Microwave ablation appears to be safe and efficacious in selected patients with primary or secondary lung tumors smaller than 3 centimeters who are not ideal surgical candidates. Serious events are rare, and pneumothorax requiring chest tubes is the most common complication. Microwave ablation is delivered in fewer sessions than radiofrequency ablation, and can achieve similar outcomes with lower morbidity. Estimates of local recurrence are highly variable and may reflect the limitations in the evidence base (e.g., retrospective nature, heterogeneity, and small sample sizes). Prospective comparisons to other therapeutic regimens, radiofrequency ablation in particular, are needed to further clarify the role of microwave ablation in treating non-small cell lung cancer. The effect of microwave ablation combined with chemotherapy regimens also requires further research.

The National Comprehensive Cancer Network (2024b) recommends image-guided thermal ablation (e.g., cryotherapy, microwave ablation, or radiofrequency ablation) for treatment of primary or secondary lung tumors smaller than 3 centimeters for patients who are medically inoperable, refuse surgery, or will not receive stereotactic ablative radiotherapy or definitive radiation therapy. Each energy modality has advantages and disadvantages. The size and location of the target tumor, risk of complications, and local expertise or operator familiarity are factors in determining choice of ablative method.

A systematic review of 355 studies and a meta-analysis of 255 studies found patients treated with microwave ablation had overall survival and disease-free survival rates that were comparable to stereotactic body radiation therapy, and superior to radiofrequency ablation. Ablated tumors were solitary with a mean tumor size of 2.83 centimeters (Laeseke, 2023). In a systematic review of eight studies of 230 patients with solitary and multiple pulmonary metastases of colorectal cancer, complication rates of microwave ablation were pneumothorax (52%), pneumonia (1.7%), and pulmonary hemorrhage (10%). Complete remission occurred in 37.0%; local control was achieved in 44.8%; and residual or progressive disease occurred in 37.0%. Disease-free survival was 43.2% at three years (Tan, 2023).

A prospective trial of 52 participants with inoperable stage 4 disease were randomized to receive either microwave ablation or radiofrequency ablation. Microwave ablation produced less intraprocedural pain (P = .0043) and a significant reduction in tumor mass from pre-therapy to 12 months follow-up (P = .0215). There were no significant differences in mortality rates or overall survival between groups. Complication rates trended lower in the microwave ablation group (33.33% versus 57.14%, P = .051) (Macchi, 2017).

A multisite, randomized controlled trial compared the effectiveness of platinum plus third-generation chemotherapy combined with microwave ablation (n = 148 with 117 tumors) to chemotherapy alone (n = 145 with 113 tumors) for treating stage 3B and 4 non-small cell lung cancer. Baseline characteristics and median follow-up periods were similar between groups. The combined treatment group experienced higher median progression-free survival (10.3 months versus 4.9 months; hazard ratio = 0.44, 95% confidence interval 0.28 to 0.53; $P < .0001$) and higher overall survival (median not reached by study end versus 12.6 months, 95% confidence interval 10.6 to 14.6 months; hazard ratio = 0.38, 95% confidence interval 0.27 to 0.53, $P < .0001$). Objective response rates, rates of disease progression, and adverse event rates were similar between groups. No deaths were attributed directly to either intervention. Ablation-related complications were reported in 76% of participants. Of those, 30 cases (20%) involved major complications, including pneumothorax (10%), pleural effusion (7%), and pulmonary infection (7%). All of the patients with these complications recovered with treatment. Minor complications occurred in 56 (38%) cases (Wei, 2020).

A systematic review and meta-analysis of eight studies compared the survival outcomes of participants with stage 1 disease who underwent either surgical resection (n = 460) or radiofrequency or microwave ablation (total n = 332). There was no significant difference in overall survival between lobectomy and microwave ablation, whereas one- and two-year overall survival rates were higher with sublobar resection (wedge resection or segmentectomy) versus radiofrequency ablation (reported as odds ratio [95% confidence interval]: 2.85 [1.33 to 6.10] versus 4.54 [2.51 to 8.21]) (Chan, 2021).

A systematic review of 12 retrospective studies (n = 985 participants with 1,336 lung nodules of various stages) found estimates of local recurrence ranged from 9% to 37%. Studies published after 2011 and those with tumors smaller than 3 to 4 centimeters reported more favorable recurrence rates. The most common complication was pneumothorax, with grade 3 or higher complications infrequently encountered (Nelson, 2019).

A systematic review and meta-analysis of seven nonrandomized comparative studies examined the overall survival of participants with various stages of disease treated with radiofrequency ablation (n = 246) and microwave ablation (n = 319). There were no significant between-group differences in overall survival rates at six months (radiofrequency ablation 89.2% versus microwave ablation 88.9%), one year (77.6% versus 79.9%), two years (59.1% versus 60.0%), and three years (36.1% versus 45.5%). There were no between-group differences in postoperative complication rates; the most common complications were pneumothorax, hemoptysis, pleural effusion, and subcutaneous emphysema (Sun, 2019).

A meta-analysis of 53 studies (n = 3,432), including 12 studies of microwave ablation, estimated that one-, two, three-, four-, and five-year overall survival rates were higher for participants treated with radiofrequency ablation compared with those treated by microwave ablation, although long-term data were limited (all $P < .05$). There were no significant between-group differences in median overall survival, median progression-free survival, median local tumor progression-free survival, complete ablation rate, or adverse event rates. In participants with pulmonary metastases, the medial overall survival was higher for those treated with radiofrequency ablation than microwave ablation (Yuan, 2019).

Kidney tumors

Renal cell carcinoma is the most common type of kidney cancer, and most patients present with localized, potentially curative disease. For small, clinically localized disease (stage T1a), partial nephrectomy is the standard of care. For most larger stage T1b tumors confined to the kidney, partial or radical nephrectomy is preferred. However, for patients who cannot tolerate or do not wish to proceed with conventional surgery or active surveillance, percutaneous image-guided thermal ablation may be a valid, curative, and tissue-sparing option.

However, there is insufficient evidence to support the safety and efficacy of microwave ablation for treating kidney tumors. The highest quality evidence from population-based registry studies and systematic reviews supports radiofrequency ablation and cryoablation. The evidence for microwave ablation is far more limited, and no randomized controlled trials of microwave ablation have been published as of this writing. Compared with partial nephrectomy, image-guided thermal ablation is associated with lower overall survival and local control, but greater preservation of renal function and lower complication rates. There is insufficient evidence to support one ablative method over another or to assess long-term outcomes.

The National Comprehensive Cancer Network (2024a) states thermal ablation (e.g., cryosurgery or radiofrequency ablation) is a treatment option for patients with clinical stage T1 renal lesions. For masses larger than 3 centimeters, thermal ablation may be an option in select patients, although it cautions ablation is associated with higher rates of local recurrence/persistence and complications with larger masses. Ablative methods may require multiple treatments to achieve the same local oncologic outcomes as conventional surgery. Microwave ablation was not mentioned specifically.

The American Urological Association recommends thermal ablation as an alternative to surgery for treatment of clinical T1a solid renal masses smaller than 3 centimeters in size. For patients who elect thermal ablation, the percutaneous technique is preferred over a surgical approach, whenever feasible, to minimize morbidity (Moderate Recommendation; Evidence Level: Grade C). Either radiofrequency ablation or cryoablation may be offered for thermal ablation (Conditional Recommendation; Evidence Level: Grade C). Microwave ablation was not mentioned specifically (Campbell, 2021).

The Society of Interventional Radiology issued the following recommendations (Morris, 2020):

- Percutaneous thermal ablation is a safe and effective treatment for patients with either small renal tumors (stage T1a, generally 4 centimeters or smaller) or suspected T1a renal cell carcinoma (Level of Evidence: C; Strength of Recommendation: Moderate).
- Percutaneous thermal ablation may be appropriate for high-risk patients with T1b renal cell carcinoma (between 4 and 7 centimeters) who are not surgical candidates (Level of Evidence D; Strength of Recommendation: Weak).
- Percutaneous thermal ablation of oligometastatic disease may be appropriate in patients with surgically resectable primary renal cell carcinoma who are not candidates for metastasectomy (Level of Evidence D; Strength of Recommendation: Weak).
- Radiofrequency ablation, cryoablation, and microwave ablation are all appropriate modalities for thermal ablation, and method of ablation should be left to the discretion of the operating physician (Level of Evidence: D; Strength of Recommendation: Weak).

The Society of Interventional Radiology issued quality improvement standards for percutaneous ablation in renal cell carcinoma. According to these standards, most patients undergoing the procedure should have T1a disease for whom major post-procedural complications have been reported in up to 6% of patients, with an overall complication rate of up to 21%. The most common complications include hemorrhage, abscess, or unintentional damage to adjacent structures. Contraindications to image-guided thermal ablation include an uncorrectable coagulopathy, active urinary tract infection, lack of safe percutaneous access to the tumor, and the inability to create an appropriate ablation zone without damaging nearby critical structures such as bowel or the ureter (Gunn, 2020).

In two systematic reviews/meta-analyses, microwave ablation offers comparable primary technical efficacy (i.e., successful eradication of tumors after the initial procedure), overall survival, cancer-specific survival, and safety to that of radiofrequency ablation and cryoablation. The main advantage of microwave ablation over the other techniques is a lower local recurrence rate. Studies were small and retrospective with a high risk of bias, variable follow up periods, and incomplete reporting of participant characteristics and outcomes, which limited the certainty of the findings. Randomized studies with longer follow-up are needed (Castellana, 2023; McClure, 2023).

A systematic review and network meta-analysis examined oncologic outcomes of image-guided thermal ablation procedures in participants with T1b renal clear cell carcinoma. Nine trials were included, but only two (n = 63) reported outcomes specifically for microwave ablation. All studies found thermal ablation methods to be safe with low recurrence rates and low occurrence of high-grade complications. The authors found no statistical differences between microwave ablation and partial or radical nephrectomy. Due to the small number and heterogeneity of studies, more trials are necessary to determine procedural benefit (Cazalas, 2021).

A systematic review and network meta-analysis of 47 low-to-moderate quality studies compared the outcomes of different nephron-sparing techniques for treatment of small renal masses: partial nephrectomy (n = 15,238), radiofrequency ablation (n = 1,877), cryoablation (n = 6,618), and microwave ablation (n = 344, five studies). The mean tumor size for microwave ablation was 2.74 centimeters; mean tumor sizes were comparable across all groups. Participants receiving thermal ablation were older and had more comorbidities than those receiving partial nephrectomy. Partial nephrectomy exhibited higher overall survival and local control than thermal ablative therapies, but not necessarily better cancer-specific mortality ($P < 0.001$). Limited evidence suggests ablative techniques may have a superior complication profile and renal function preservation compared to partial nephrectomy, but the superiority of any one ablative method has not been established (Uhlig, 2019).

In 2024, we added new evidence reviews and updated the references. No policy changes are warranted.

References

On May 22, 2024, we searched PubMed and the databases of the Cochrane Library, the U.K. National Health Services Centre for Reviews and Dissemination, the Agency for Healthcare Research and Quality, and the Centers for Medicare & Medicaid Services. Search terms were "microwave ablation," "lung neoplasm" (MeSH), "lung cancer," and "renal cell carcinoma." We included the best available evidence according to established evidence hierarchies (typically systematic reviews, meta-analyses, and full economic analyses, where available) and professional guidelines based on such evidence and clinical expertise.

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Policy updates

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