Microwave thermotherapy for lung and kidney tumors

Clinical Policy ID: CCP.1528

Recent review date: 7/2025

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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, 2025b):

- The member is 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 clinically proven and, therefore, may be medically necessary when all of the following are met (National Comprehensive Cancer Network, 2025a):

- The member either is not a candidate for surgery due to other medical conditions or presents a significant risk of illness or death from the procedure.
- The tumor is a clinical stage one renal lesion that is 3 centimeters or less in diameter.

Limitations

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

Overall efficacy and professional recommendations

Microwave ablation is a safe and effective treatment for malignant lung tumors in appropriately selected individuals, a conclusion supported by a substantial body of evidence and professional guidance. The National Comprehensive Cancer Network (2025b) recommends image-guided thermal ablation for primary or secondary lung tumors smaller than 3 centimeters in non-surgical candidates, with the choice of modality depending on tumor characteristics, complication risks, and operator expertise. Generally, microwave ablation is most effective for individuals with tumors smaller than 3 centimeters who are not ideal candidates for surgery. An expert consensus panel from the American Association for Thoracic Surgery identifies microwave ablation, as a form of image-guided thermal ablation, as a reasonable treatment option for high-risk patients with stage I non-small cell lung cancer who are not candidates for standard surgical resection. Surgical resection is generally favored when deemed safe, while stereotactic ablative radiotherapy is recommended as the preferred non-surgical modality. Image-guided thermal ablation techniques, including microwave ablation, are considered subsequent alternatives for patients who are ineligible for, or decline, both surgery and stereotactic ablative radiotherapy. The guideline emphasizes a tiered, individualized approach to treatment selection based on patient risk, tumor characteristics, and patient preferences (Pennathur, 2025).

Comparison with surgery and other ablative modalities

Compared to surgery, microwave ablation offers faster recovery and lower morbidity, and it demonstrates comparable or superior outcomes to other modalities in specific contexts. For stage 1 disease, one meta-analysis found no significant difference in overall survival between lobectomy and microwave ablation (Chan, 2021), while another large review found survival rates comparable to stereotactic body radiation therapy and superior to radiofrequency ablation (Laeseke, 2023). Direct comparisons with radiofrequency ablation highlight specific benefits, including less intraprocedural pain ($P = .0043$), greater tumor mass reduction ($P = .0215$), and a significantly shorter ablation duration (Macchi, 2017; Liu, 2025). Evidence on long-term survival is conflicting; while one meta-analysis found no difference in survival (Sun, 2019), another reported higher one- through five-year survival rates for radiofrequency ablation (all $P < .05$) (Yuan, 2019).

Combination therapy and specific patient populations

The role of microwave ablation has also been explored in combination with systemic treatments and for specific metastatic disease. For participants with stage 3B and 4 non-small cell lung cancer, adding microwave ablation (n = 148) to chemotherapy alone (n = 145) significantly improved both progression-free survival (10.3 vs. 4.9 months; $P < .0001$) and overall survival (median not reached vs. 12.6 months; $P < .0001$) (Wei, 2020). In participants with pulmonary metastases from colorectal cancer, a systematic review reported complete remission in 37.0%, local control in 44.8%, and a three-year disease-free survival of 43.2% following microwave ablation (Tan, 2023).

Complications, recurrence, and evidence gaps

While generally safe, microwave ablation is associated with known complications, and its effectiveness is limited by variable local recurrence rates and gaps in the evidence. The most common complication is pneumothorax requiring chest tube placement (10% to 52%), with other risks including pleural effusion (7% to 17.22%), pulmonary hemorrhage (10%), and pulmonary infection (7%) (Liu, 2025; Nelson, 2019; Tan, 2023; Wei, 2020). Furthermore, a key limitation is the highly variable local recurrence rate (9% to 37%), which likely reflects the retrospective nature and heterogeneity of existing studies (Nelson, 2019). The efficacy of ablation also diminishes for tumors exceeding 3 centimeters, underscoring the need for prospective, comparative trials to clarify its role (Lanuti, 2025).

Kidney tumors

Evidence and guideline support

For small, localized kidney tumors, microwave ablation is a viable, tissue-sparing option for non-surgical candidates, supported by key professional guidelines and emerging evidence. While partial nephrectomy remains the standard of care for T1a renal cell carcinoma, guidelines from the National Comprehensive Cancer Network (2025a) and the Society of Interventional Radiology (Morris, 2020) now include microwave ablation as an appropriate technique for small renal masses, typically those 3 centimeters or smaller. This support exists even as the evidence base for microwave ablation remains less robust than for radiofrequency ablation or cryoablation, with no randomized controlled trials published to date. 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).

Comparative efficacy and safety

Systematic reviews find that microwave ablation offers favorable oncologic outcomes. A 2025 meta-analysis reported a 5-year cancer-specific survival rate of 98% and a five-year local control rate of 92% for tumors smaller than 4 centimeters (Huang, 2025). Other reviews suggest microwave ablation provides comparable technical efficacy and survival to radiofrequency ablation and cryoablation, with a potentially lower rate of local recurrence (Castellana, 2023; McClure, 2023). When compared to partial nephrectomy, thermal ablation techniques generally show lower overall survival and local control but offer superior preservation of renal function and lower complication rates (Uhlig, 2019).

Complications and evidence limitations

Microwave ablation is a technical procedure with known risks. Major post-procedural complications occur in up to six percent of participants, with an overall complication rate of up to 21% (Gunn, 2020). Common complications include hemorrhage, abscess, and damage to adjacent structures (e.g., bowel, ureter). The primary limitation in the field remains the lack of high-quality, long-term data from prospective, randomized trials. Therefore, while microwave ablation is a recommended treatment option for appropriately selected individuals, further research is needed to solidify its long-term comparative effectiveness (Castellana, 2023; Huang, 2025).

In 2025, we updated the coverage policy to include microwave ablation for kidney tumors as a covered service for appropriately selected patients, reorganized the discussion section with clearer thematic headings, and updated references. We added four new 2025 publications: one systematic review/meta-analysis (Huang), one systematic review (Lanuti), one meta-analysis (Liu), and one expert consensus guideline (Pennathur). We also updated the National Comprehensive Cancer Network guidelines for kidney and lung cancers to their 2025 versions.

References

On June 6, 2025, 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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7/2024: Policy references updated.

7/2025: Policy references updated. Coverage updated.