Laser Interstitial Thermal Therapy (LITT) is considered experimental, investigational or unproven for all indications.

Overview

This Coverage Policy addresses laser interstitial thermal therapy, also known as magnetic resonance-guided laser interstitial thermal therapy (MRgLITT).

General Background

Laser interstitial thermal therapy (LITT) uses thermal energy to induce cell death by damaging DNA and causing protein denaturation. The goal of LITT is to achieve selective thermal injury of pathological tissue while maintaining a sharp thermal border between the tumor and normal brain tissues. LITT is one of several energy delivery methods using interstitial high heat to destroy tissue; another example is radiofrequency ablation (RFA). LITT has been explored since the late 1970s, but recent advances in probe design, cooling mechanisms, and real-time magnetic resonance (MR) thermography have increased interest in LITT.

LITT is also referred to as magnetic resonance-guided laser interstitial thermal therapy (MRgLITT), laser induced thermal therapy/thermotherapy, interstitial laser photoacoagulation/coagulation, interstitial laser ablation, MRI-guided laser surgery, and MRI-guided percutaneous laser ablation.
LITT involves the creation of a small cranial bur hole, through which a thin laser fiber is introduced into the brain until the tip reaches the targeted location. After the probe is inserted in the operating room, the thermal ablation procedure is performed in the MRI suite. Thereafter, the patient is moved back into the operating room for probe removal. In real time, laser-induced temperature change is monitored by MR thermometry and correlated with predicted cell death by computer models. The workstation is located in the MRI control room. The surgeon controls the probe position inside the MRI and regulates ablation time and intensity on the workstation. Alternatively, the whole procedure could be performed under intraoperative MRI monitoring.

**Proposed Indications**
The clinical indications for LITT are currently being defined. Ablation of deep-seated, eloquently situated primary and metastatic brain tumors, epileptogenic foci, and radiation necrosis have been described in the literature. It has been proposed that LITT provides minimally invasive options for treating surgically challenging tumors in locations that would otherwise have represented an intrinsic comorbidity by the approach itself. Novel indications for LITT will continue to emerge as laser technologies improve and are developed. Some studies involve the use of LITT outside of the brain.

**Risks**
Specific risks of LITT include damage to the cerebral vasculature by the laser probe which could result in hemorrhage or pseudoaneurysm that may require subsequent open or endovascular surgery. Although MR thermometry allows precise control of the ablated tissue, the risk of damage to the critical cortex areas and white matter tracts by the probe or thermal energy remains. Delayed transitory neurologic deficits due to increasing brain edema usually resolve after steroid therapy. Other potential limitations include the necessity of training in stereotactic surgery which requires the availability of special equipment and established logistics with an MR scanner. Nonspecific adverse effects include balance disorder, dizziness, and headache. Brain abscess, seizures, and wound infection have also been reported. Risks and contraindications for MRI are also applicable to LITT. The exact rates of various complications have not yet been defined for LITT. Surgical site infections, bleeding, and anesthesia-related risks are thought to be lower in LITT than those in open craniotomy. Neurosurgeons considering LITT balance the potential benefits of surgical treatment with the risks of surgery in patients with comorbidities (Belykh, et al., 2017; Lagman, et al., 2017; Shukla , et al., 2017; Riordan, et al., 2014).

**U.S. Food and Drug Administration (FDA)**
LITT/MRgLITT is a procedure not subject to FDA regulation. There are numerous FDA-approved laser devices. On 04/25/2018, the FDA issued a FDA Alert on MR-Guided Laser Interstitial Thermal Therapy Devices with a letter to providers stating the FDA is currently evaluating data which suggests that potentially inaccurate MR thermometry information can be displayed during treatment. “For example, MR parameters such as voxel size (measurement of the image resolution or detail) and MR image acquisition time (e.g., up to 8 seconds) may contribute to inaccurate MR thermometry readings and potential errors in the ablation assessment. In addition, MRgLITT devices may not account for the continued thermal spread of energy to the surrounding tissue (as the target ablation area returns to its baseline temperature), which may result in an underestimation of thermal damage.”

The NeuroBlate® System (Monteris Medical, Plymouth, MN) and the Visualase® Thermal Therapy System (Medtronic, Louisville, CO) are FDA-approved devices that are being used in LITT. Both systems can be used with intraoperative MRI, navigation or stereotactic systems, and provide predictive thermal dosage lines to estimate ablation volume.

Monteris NeuroBlate System: The NeuroBlate System is a collection of MRI-compatible laser devices and accessories that create an MRI guided delivery of precision thermal therapy in the practice of neurosurgery. Indications for use include:

- to ablate, necrotize, or coagulate soft tissue through interstitial irradiation or thermal therapy in medicine and surgery in the discipline of neurosurgery with 1064 nm lasers
Medical Coverage Policy: 0528

Visualase Thermal Therapy System: The Visualase Thermal Therapy System comprises four devices: a laser energy source, a cooled laser applicator, a pump for circulating coolant through the applicator, and a computer workstation with magnetic resonance imaging (MRI) analysis software for determination and visualization of relative changes in tissue temperature during therapy. Indications for use include:

- to necrotize or coagulate soft tissue through interstitial irradiation or thermal therapy under magnetic resonance imaging (MRI) guidance in medicine and surgery in cardiovascular thoracic surgery (excluding the heart and the vessels in the pericardial sac), dermatology, ear-nose-throat surgery, gastroenterology, general surgery, gynecology, head and neck surgery, neurosurgery, plastic surgery, orthopedics, pulmonology, radiology, and urology, for wavelengths 80Onm through 1064nm
- when therapy is performed under MRI guidance, and when data from compatible MRI sequences is available, the Visualase system can process images to determine relative changes in tissue temperature during therapy. The image data may be manipulated and viewed in a number of different ways and the values of data at certain selected points may be monitored and/or displayed over time

Brain – Literature Review
The use of MR-guided LITT for treatment of benign and malignant brain tumors, intractable epilepsy, and radiation necrosis is evolving. A review of the current peer-reviewed literature reveals three areas of concern: 1) safety/adverse events, especially during technology learning curves 2) optimal patient populations are still being defined and 3) lack of large, comparative prospective studies. Some authors propose use in patients with tumors in or near areas of eloquence, if difficult to reach with conventional surgery, or who have already undergone radiation therapy or conventional surgery. Other authors specify use in patients with symptomatic advancing post-radiation treatment effect. Some authors recommend use only in high-grade gliomas (WHO grade III or IV). Others suggest use in the elderly and/or those with comorbidities that preclude open surgical procedures because of potentially high risks of morbidity and mortality. MRgLITT is proposed as an alternative to invasive surgery to target epileptogenic foci in patients with medically refractory focal epilepsy. The gold standard for surgical control is open surgical resections aimed at localizing and excising the epileptogenic zone to achieve seizure freedom. In temporal lobe epilepsy, the most common form of drug-resistant epilepsy, open surgery involves anterior temporal lobectomy (ATL) or, as an alternative option, selective amygdalohippocampotomy (SAH), which spares resection of the anterior temporal lobe. Large randomized controlled trials are needed to establish the safety.

Lagman et al. (2017) conducted a quantitative analysis of retrospective case reports and case series, evaluating results of 223 MRgLITT patients (Visualase, n=154 [69%]; NeuroBlate n=69 [31%]). Epilepsy was the most common indication for Visualase therapy. Brain mass was the most common indication in patients undergoing NeuroBlate therapy. There were no significant differences, except in age, wherein the NeuroBlate group was nearly twice as old as the Visualase group. The authors note that head-to-head comparison of these systems was difficult given the variance in indications (and therefore patient population) and disparate literature. They concluded MRgLITT procedures have demonstrated effectiveness in the treatment of a variety of epilepsy etiologies and tumor pathologies but long-term outcomes have yet to be fully elucidated.

Kamath et al. (2017) retrospectively reported treatment of 120 patients (133 lesions) with MRgLITT. There were several lesion types: glioblastomas (GBM, WHO grade IV glioma, n=57), metastases (n=25), WHO grade III gliomas (n=12), WHO grade II gliomas (n=12), epilepsy foci (n=11), WHO grade I gliomas (n=8), radiation necrosis (n=6), teratoma (n=1), and encephalocele (n=1). The NeuroBlate system was used. Median follow-up was 9.5 months with 18 patients lost to follow-up (15 GBM patients and three metastasis patients). The rate of complications/unexpected readmission was 6.0%, and the mortality rate was 2.2%. With high-grade tumors, tumor volumes >3 cm in diameter trended toward a higher rate of complication (p=0.056). Median progression-free survival (PFS) and overall survival (OS) for recurrent GBM were 7.4 and 11.6 months, respectively. As a frontline treatment for newly diagnosed GBM median PFS and OS were 5.9 and 11.4 months, respectively. For metastases, median PFS was not yet reached and OS was 17.2 months. There were eight perioperative complications (6.0%) and eight unplanned readmissions (6.0%). Of these there were three perioperative
mortalities (2.2%). The authors noted interstitial laser ablation may offer a novel alternative to traditional open craniotomy in properly selected patients; further studies will be useful in guiding therapy.

Patel et al. (2016) published retrospective MRgLITT data on 102 patients who required intervention for intracranial tumors (87 patients), chronic pain syndrome (cingulotomy, five patients), or epilepsy (ten patients). The procedure was completed in 98% (100) of these patients. The Visualase system was used. Ninety-two patients (90.2%) had undergone previous treatment for their intracranial tumors. There were 27 cases of morbidity, including new-onset neurological deficits, and two perioperative deaths. Fourteen patients (13.7%) developed new deficits after the MRgLITT procedure, and of those 14 patients, 64.3% (n=9) had complete resolution of deficits within one month, 7.1% (n=1) had partial resolution of symptoms within one month, 14.3% (n=2) had not had resolution of symptoms at the most recent follow-up, and 14.3% (n=2) died without resolution of symptoms. The 30-day readmission rate was 5.6%. The authors concluded that MRgLITT, although minimally invasive, must be used with caution. Thermal damage to critical and eloquent structures can occur despite MRI guidance. Once the learning curve was overcome, the overall procedural complication rate was low, and most patients were discharged within 24 hours, with a relatively low readmission rate. The author noted that the therapeutic role of MRgLITT in various intracranial diseases will require larger and more rigorous studies.

Barnett et al. (2016) published a meta-analysis of retrospective and prospective studies which examined extent of resection (EOR) or extent of ablation (EOA) and major complications (defined as neurocognitive or functional complications which last >3 months duration after surgery) associated with either brain laser interstitial thermal therapy (LITT) or open craniotomy. Patients had high-grade primary or recurrent brain tumors (WHO grade III or IV) in or near areas of eloquence and/or of a deep-seated nature (e.g. brain stem). Websites for both Monteris Medical and Medtronic were searched for clinical studies associated with the NeuroBlate (Monteris) and Visualase (Medtronic). Eight studies on brain LITT (n = 79 patients) and 12 craniotomy studies (n = 1,036 patients) were identified which examined either/both EOR/EOA and complications. Meta-analysis demonstrated an EOA/EOR of 85.4 ± 10.6% with brain LITT versus 77.0 ± 40% with craniotomy (p= 0.01). Meta-analysis of proportions of major complications for each individual therapy demonstrated major complications of 5.7% and 13.8% for LITT and craniotomy, respectively. The authors stated that a statistically significant improvement in EOR/EOA along with a reduction in major neurocognitive complications appears to be possible with LITT versus craniotomy in patients with high-grade gliomas. A limitation of this meta-analysis is the inclusion of retrospective studies and the comparison of varying study protocols and populations to each other.

Pruitt et al. (2017) reported retrospective results on 46 patients (CNS tumors n=13, radiation necrosis n=2, epilepsy n=31) who underwent 49 LITT procedures at one institution. The authors stated that the intent of the article was to “examine our experience with LITT, associated adverse events, and the lessons learned”. The Medtronic Visualase system was used. Some form of adverse event occurred in 11 (22.4%) of 49 procedures. These included four catheter malpositions, three intracranial hemorrhages, three cases of neurological deficit related to thermal injury, and one technical malfunction resulting in an aborted procedure. Of these, direct thermal injury was the only cause of prolonged neurological morbidity and occurred in three of 49 procedures. Use of frameless stereotaxy and increased numbers of devices were associated with significantly increased complication rates (p < 0.05). The authors concluded MRgLITT is a promising new tool for the treatment of patients with brain tumors and epilepsy. The authors stated “As is the case when adopting any new technology, a careful and honest evaluation of suboptimal circumstances will result in refinement of technique and improved clinical outcomes.”

Mohammadi et al. (2014) published retrospective MRgLITT findings on 34 difficult-to-access high-grade glioma (DTA-HGG) (24 glioblastoma, 10 anaplastic) patients. Using the NeuroBlate system, 16 procedures (16 patients) were performed as upfront treatment for newly diagnosed HGG and 19 procedures (18 patients) were performed for treatment of recurrent disease. The median patient follow-up was 7.2 months. Overall 71% (25/35) of cases progressed during follow-up. The estimated median PFS for the cohort was 5.1 months. Any type of complication was observed after 13/35 LITT procedures (37%). The most common complication was a worsening of preoperative neurological deficit (usually motor) in seven (20%) cases. In five (14%) cases, the new deficit resolved within a few days; however, the new deficit was permanent in two (6%) cases. The authors proposed MRgLITT can be used effectively for treatment of DTA-HGGs.
Youngerman et al. (2018) retrospectively reported selective laser amygdalohippocampotomy (SLAH) results in 30 patients; 12 had non-mesial temporal sclerosis (MTS) mesial temporal lobe epilepsy (MTLE) and 18 patients had MTS. All patients used the Visualase system and had at least 12 months follow-up. Nine patients had postoperative seizures, four within the first 24 hours of surgery, and an additional five within the first 14 days. The authors stated that postoperative seizures did not predict long-term seizure outcome. Five patients ultimately obtained seizure freedom and four did not. Engel class I seizure freedom was achieved in seven of 12 non-MTS patients (58%) and 10 of 18 MTS patients (56%), with no significant difference between groups (p=0.88). Three patients had procedural complications without long-term sequelae. The authors noted that seizure-free rates are slightly lower than typically observed with surgical resection (60-80%); however, SLAH is less invasive than open surgery.

Kang et al. (2016) prospectively tracked seizure outcome in 20 patients with drug-resistant mesial temporal lobe epilepsy (MTLE) who underwent MRgLITT with the Visualase system. Two patients had mesial temporal lobe MRI lesions (one suspected low-grade glioma and one biopsy-proven low-grade glioma). Median follow-up was 13.4 months. The calculated proportion of patients free of seizures impairing consciousness (including those with auras only) was as follows: eight of 15 patients (53%) after six months, four of 11 patients (36.4%) after one year, three of five patients (60%) at two year follow-up. Four patients had an anterior temporal lobectomy (ATL) after MRgLITT because of persistent seizures. The authors proposed that MRgLITT is a safe alternative to ATL in patients with medically intractable mTLE. Individualized assessment is warranted to determine whether the reduced odds of seizure freedom are worth the reduction in risk, discomfort, and recovery time.

In a prospective comparison, Drane et al. (2015) reported pre- and postsurgical data for 19 patients undergoing stereotactic laser amygdalohippocampotomy (SLAH) and a comparable series of 39 patients undergoing traditional open anteromedial temporal lobe resections. Tests of naming and recognition of common nouns (Boston Naming Test) and famous persons were compared. Naming and recognition assessment was compared from different time points (e.g., six-month follow-up for SLAH and one-year follow-up for open resection). When examined on an individual subject basis, no SLAH patients experienced any performance declines on these measures. In contrast, 32 of the 39 patients undergoing standard surgical approaches declined on one or more measures for both object types (p<0.001). The authors concluded that temporal lobe epilepsy (TLE) patients undergoing SLAH had better outcomes for naming and recognition of famous faces and naming of common objects than those receiving standard resections. The majority of patients in the open resection group experienced a decline in either naming or recognition functions depending on side of surgery. Conversely, performance accuracy remained unchanged or improved in all patients in the SLAH group.

Hawasli et al. (2013) prospectively recruited 17 patients with glial neoplasms (n=111), metastatic tumors (n=5), and an epilepsy focus (n=1) who underwent LITT with the Neuroblate System. Nine patients were treated postoperatively with chemotherapy, six were treated with radiotherapy, one required a craniotomy at a different location, and one required repeat LITT. Eight patients experienced disease progression. Five patients died (three patients died of central nervous system disease). Ten patients experienced no morbidities. Seven patients experienced perioperative morbidities. Preliminary overall median progression-free survival and survival from LITT in tumor patients were 7.6 and 10.9 months, respectively. The authors concluded that LITT may be considered for select patients; however this small cohort has not been followed for a sufficient length of time necessitating future outcomes studies.

Willie et al. (2014) prospectively evaluated stereotactic laser amygdalohippocampotomy (SLAH) in 13 adult patients with intractable MTLE. The Visualase system was used. Median follow-up was 14 months. Two subjects had undergone placement of vagal nerve stimulators prior to current surgical evaluation, and two subjects had undergone previous open temporal lobe surgeries at other institutions. Willie et al. reported 77% (10/13) of patients achieved meaningful seizure reduction, of which 54% (7/13) were free of disabling seizures. The authors note that stereotactic laser amygdalohippocampotomy (SLAH) with real-time magnetic resonance thermal imaging (MRTI) guidance is a safe and effective alternative to open surgery.

Waseem et al. (2015) prospectively compared one year results of five patients who underwent MRgLITT to data taken from seven patients undergoing AMTL resection. Patients’ diagnosis was medically resistant mesial temporal lobe epilepsy (MTLE). One AMTL resection patient had a complication of aseptic meningitis. One
MRgLITT patient experienced an early postoperative seizure, and two MRgLITT patients had a partial visual field deficit. Seizure-freedom rates were comparable (80% [MRgLITT] and 100% [AMTL]; p>0.05) beyond one year post-surgery. The authors proposed patients who are 50 years or older can potentially achieve similar outcomes to microsurgery with the added benefit of faster recovery.

Sloan et al. (2013) conducted a prospective Phase I thermal dose–escalation trial assessing the safety and efficacy of NeuroBlate in recurrent glioblastoma multiforme (rGBM). The study included ten patients in whom standard therapy (radiotherapy with or without chemotherapy) had failed. The study median follow-up was eight months. The median survival was 316 days (range 62–767 days). Three patients improved neurologically, six remained stable, and one worsened. Steroid-responsive treatment-related edema occurred in all patients but one. Three had Grade 3 adverse events at the highest dose. The authors concluded that NeuroBlate holds the promise of enabling the delivery of thermal ablation in real time with surgical precision in some patients with brain tumors in whom safe, conventional surgery is impractical or impossible.

**Brain – Professional Societies/Organizations**

A review of several National Comprehensive Cancer Network® (NCCN) Clinical Guidelines in Oncology™ did not identify any mention of laser interstitial thermal therapy.


The American Academy of Neurology (AAN) does not address LITT in their guidelines. A guideline titled Thermography in Neurologic Practice (March 1990) is noted as Retired on October 17, 2004.

The American Epilepsy Society lists several Evidence-based Guidelines and Practice Parameters; none address laser interstitial thermal therapy.

The Epilepsy Foundation of America website includes Information For Professionals which addresses magnetic resonance-guided laser interstitial thermal therapy (MRgLITT). It states the best candidates for MRgLITT are patients with a well-defined epileptogenic focus. When focal seizures are uncontrolled by antiseizure drugs, a solitary lesion < 2 cm on high-resolution MRI of the brain and a concordant presurgical evaluation is the optimal preoperative situation for MRgLITT.

**Breast – Literature Review**

Percutaneous treatments have been developed to reduce morbidity and improve esthetic results. A few studies have been published evaluating LITT of targeted nodules in malignant and benign breast disease. Most studies do not utilize the NeuroBlate or Visualase system. In a 2017 review, Fleming et al. suggests tumors larger than two cm do not appear to be good candidates for laser therapy, nor do those with an extensive in situ component. Although lasers can be placed under ultrasound or stereotactic guidance, the treatment zone is not well visualized, and MRI may be more useful in this regard. Conventional imaging techniques to explore breasts are x-ray and ultrasound (US). Kerbage et al. notes "specific and marginal indications require MRI (lobular cancer, young patients with dense breasts and undefined breast diseases, multifocal cancers). Thus, it appears that MRI is not the imaging to be privileged, even if MRI is used successfully to guide LITT in other organs.”

Mauri et al. (2016) conducted a meta-analysis of 45 studies, including 1,156 breast cancer patients and 1,168 lesions. Radiofrequency (n=577; 50%), microwaves (n=78; 7%), laser (n=227; 19%), cryoablation (n=156; 13%) and high-intensity focused ultrasound (HIFU, n=129; 11%) were used. The rate of technical success was defined as the rate of patients in whom the operator was able to technically complete the ablation procedure; technical efficacy was defined as the rate of lesions completely ablated. The reference standard for complete success was histopathology of the excised specimen or imaging follow-up. Differences between techniques were not significant for technical success (p=0.449), major complications (p=0.181) or minor complications (p=0.762), but significant for technique efficacy (p=0.009). Pooled technique efficacy was 75% (radiofrequency=82%; cryoablation=75%; laser=59%; HiFU=49%). The authors concluded that imaging-guided percutaneous ablation
techniques of breast cancer have a high rate of technical success, while technique efficacy remains suboptimal and complication rates are relatively low (6–8%).

Dowlatshahi et al. (2002) retrospectively studied 54 patients with mammographically-detected circumscribed breast cancers (50 invasive, four in-situ). A laser needle, wire localization, and stereotactic images were used. Each patient was treated with LITT prior to definitive surgical, radiation and if indicated, chemohormonal adjuvant therapy. Two patients opted for laser therapy without surgery. All patients subsequently underwent surgical removal of the laser-treated lesions one to eight weeks later to determine the rate of complete ablation. The overall success rate for complete tumor ablation was 70%. The authors state that interstitial laser therapy has the potential to change the paradigm for local treatment of mammographically detected well-defined breast cancers.

Basu et al. (1999) published a small prospective case series on 27 patients younger than 35 years who underwent laser phototherapy (interstitial laser hyperthermia) of their breast fibroadenomas. Lumps of more than one year in duration were selected. Under real-time ultrasound monitoring, Nd:YAG laser was used. Follow-up at eight weeks showed reduction in size in all although mild tenderness was still present. At eight weeks, 10 patients with residual lumps of more than one cm in diameter underwent excision biopsy with subsequent histopathological examination. There were minimal scars (2–3mm) and no keloid or abscess formation.

Breast – Professional Societies/Organizations
The American Society of Breast Surgeons (ASBS) Consensus Guideline on the Use of Transcutaneous and Percutaneous Methods for the Treatment of Benign and Malignant Tumors of the Breast notes that percutaneous and/or transcutaneous treatments (e.g., ablation by focused ultrasound, laser, cryotherapy, microwave, and radiofrequency) of malignant tumors of the breast are not specifically approved by the FDA, though some ablative technologies are approved for treatment of benign and malignant soft tissue tumors. Therefore, ablative and percutaneous excisional treatments for breast cancer are considered investigational and should not be performed outside the realm of a clinical trial (ASBS, 2017).

The National Comprehensive Cancer Network® (NCCN®) national guidance that is published for the treatment of breast cancer (1.2018 - March 20, 2018) does not address laser interstitial thermal therapy. Under Distance sites of recurrence requiring consideration of therapies local to the metastatic site, the NCCN notes hyperthermia literature addresses primarily chest wall recurrences.

Prostate – Literature Review
Zhang et al. (2011) conducted a prospective randomized controlled trial in patients age ≥65 years with benign prostatic hyperplasia (BPH) to evaluate the clinical effectiveness of channel transurethral resection of the prostate (C-TURP) combined with an interstitial laser coagulation (ILC) technique. Channel TURP (C-TURP) refers to limited resection of the obstructing tissue to open the bladder outlet. A total of 150 consecutive BPH patients were randomized into the ILC+C-TURP group (n=50), the ILC group (n=50) and the TURP group (n=50). A diode laser was used. The international prostate symptom score (IPSS) at the 48-month follow-up period was used as the primary measurement. Three, six, 24 and 48 months after surgery, the IPSS in the TURP group was significantly superior to that in the C TURP group (p<0.05). When compared with baseline, the IPSS in the C-TURP+ILC, ILC, and TURP groups was decreased by 70.6, 45.4, and 81.0%, respectively (ILC vs. C-TURP+ILC or TURP, p<0.01), at 48 months after surgery. The authors stated that C-TURP and ILC are technically complementary. C-TURP+ILC can persistently maintain an unblocked urinary tract, improve urination and QOL after operation. Therefore the authors concluded that it is an alternative for the treatment of high-risk elderly patients or those with a limited life expectancy.

Ng et al. (2005) reported prospective results of interstitial laser coagulation (ILC) in 66 men with bothersome lower urinary-tract symptoms (LUTS) secondary to benign prostatic obstruction refractory to medical management. Patients were stratified into two groups: those treated during the first two years (group 1; n=47) and those treated during the latest two years (group 2; n=19). This distinction was made because patient-selection criteria and surgical technique evolved as they gained experience with ILC, and these changes were fully employed during the latest two-year period. A diode laser was used. Maximum flow rates improved by 47% and 85% in groups 1 and 2, respectively, at 12 months postoperatively compared with baseline (p=0.04). The
incidence of adverse events was similar in the two groups. The authors stated that improvements in surgical technique and patient selection corresponded to significantly higher maximum flow rates without an increase in adverse events.

Tsui et al. (2003) compared patients with symptomatic BPH treated by transurethral resection of the prostate (TURP, n=60), and patients treated by laser prostatectomy (temperature feedback interstitial laser coagulation, ILC, n=60). The results of treatment after ILC were compared with the results of the 60 patients who had received TURP from the same group of physicians in an earlier time period. For ILC, the Indigo® 830e ILC module used in this study was a gallium-aluminum-arsenide diode laser. Forty-five of the 60 ILC patients provided complete data over 16 months for analysis. All subjective and objective urinary parameters showed significant improvement after ILC. There was dissatisfaction with ILC treatment effects in three patients (5%). Less than 5% of patients developed sexual dysfunction, persistent urinary incontinence, or retrograde ejaculation. The change in prostate volume after ILC was also significant, showing a reduction of 26.8% (46.6 to 34.1 ml) over 12 months. The mean duration of stay was significantly lower (5.9 to 2.5 days, p<0.001) following ILC treatment. Significantly different (p<0.001) numbers of patients showed psychological/ social delays after ILC than after TURP.

Terada et al. (2004) used a YAG-laser source to perform interstitial laser coagulation (ILC) on 82 symptomatic BPH patients. Seven patients died and 17 were lost to follow-up. The mean follow-up period was 48.4 months (range, 3–108 months). A total of 59 patients (72%) did not need any additional treatment at 12 months and 30 patients (37%) did not require additional treatment during the entire follow-up period. A total of 29 patients (35%) were retreated during follow-up. Transurethral prostate resection was performed in 18 patients (22%). The indications for TURP were lasting discomfort of patients (nine patients), large post -void residual urine volume (four patients), recurrent UTI (three patients) or gross hematuria (two patients). The remaining 11 patients (13%) were offered additional pharmacotherapy. The authors concluded that ILC is an effective alternative to TURP, especially for younger patients.

Lepor et al. (2015) prospectively studied 25 men with stage T1c and T2a disease, PSA <10 ng/ml, and Gleason score <8. The Visualase system was used to deliver MRI-guided focal laser ablation (FLA). At three months follow up, mean PSA decrease between baseline and three months was 2.3 ng/ml (44.2%). Of 28 sites subjected to target biopsy after FLA, 26 (96%) showed no evidence of prostate cancer. There were minimal adverse events. The authors noted the short follow-up time as a limitation of the study.

Prostate – Professional Societies/Organizations
The National Comprehensive Cancer Network® (NCCN®) national guidance that is published for the treatment of prostate cancer (2.2018 - March 8, 2018) does not address laser interstitial thermal therapy.


Osteoid Osteoma – Literature Review
Gangi et al. (2007) retrospectively reported use of a diode laser to perform interstitial laser ablation (ILA) on 114 patients suspected of having osteoid osteoma. One week after ILA, 112 patients had a VAS pain score of zero. One week after ILA, one patient had pain that persisted for two months because of reflex sympathetic dystrophy. At follow-up (mean, 58.5 months), six patients had recurrence of pain from six weeks to 27 months after the initial ILA. These recurrences were treated successfully with a second ILA. Only one unsuccessful treatment was encountered. It is unclear what if any subset of patients from the Gangi et al. (2007) study is included in the Tsoumakidou et al. (2016) study. Tsoumakidou et al. (2016) used a diode laser with combined CT and fluoroscopic guidance in 57 spinal osteoid osteoma patients. OO was in the vertebral body for 18 of 57 patients, the neural arch for 21 of 57 patients, and the articular process for 18 of 57 patients. Primary clinical success at one month was 98.2%. Total recurrence rate was 5.3%. No major complications were noted.

Roqueplan et al (2010) reported using computed tomography (CT)-guided interstitial laser ablation (ILA) in 100 patients with osteoid osteoma. Results were retrospectively compared with 26 patients treated with percutaneous trephine resection (PR). The median follow-up for CT-guided ILA treated patients was 47 months.
The clinical success rate was 96% at six-month and 94% at 24-month follow-up, with 4% (4/100) transient complications (one common fibular nerve contusion, one hematoma, one infection and one tendinitis). Four ILA procedures were repeated, one because of initial failure and three because of recurrence (at 6.5, 15 and 32 months). Two were successful and two failed again. In the group treated by PR, the clinical success rate was 96% at six-month and 95% at 24-month follow-up, with 12% (3/26) transient complications (one meralgia, two skin burns).

Fuchs et al. (2014) prospectively followed 35 osteoid osteoma patients treated with MRI-guided laser ablation for a mean time of 13.6 months. MRI follow-up demonstrated 28/35 patients (80%) showed a typical post-interventional target-like appearance of the ablated area, followed by a constant shrinking process along with a steady decrease in periablation changes such as peripheral bone edema. The authors stated that clinical success was achieved in 32/35 (91%).

Osteoid Osteoma – Professional Societies/Organizations

American Academy of Orthopaedic Surgeons Clinical Practice Guidelines do not address osteoid osteoma.

Other- Literature Review
Thyroid: In a small randomized trial, Døssing et al. (2013) studied 44 patients with recurrent, benign (predominantly cystic) thyroid nodules who were randomized to a single aspiration with (n=22) or without (n=22) subsequent interstitial laser photocoagulation (ILP). A diode laser was used under US guidance. At six months follow-up results showed no significant difference between the groups (p=0.001) in reduction of median total nodule volume. In the ILP group remission of the cystic part was obtained in 15 of 22 (68%) patients, compared with four of 22 (18%) patients treated with aspiration alone (p=0.002). The authors concluded that ILP compared to aspiration alone, for recurrent benign predominantly cystic thyroid nodules, increases the remission rate from 18–68%.

Metastases: Vogl et al. (2014) reported on 594 patients with colorectal cancer (CRC) liver metastases who underwent LITT. The median PFS was 13 months. The 1-, 2-, 3-, 4-, and 5-year PFS rates were 51.3%, 35.4%, 30.7%, 25.4%, and 22.3%, respectively.

Vogl et al. (2016) compared 109 patients with CRC lung metastases who have undergone ablation therapy performed using laser-induced thermotherapy (LITT, n=21), radiofrequency ablation (RFA, n=41), or microwave ablation (MWA, n=47). Follow-up visits occurring at 3, 6, 12, 18, and 24 months after ablation. The progression-free survival rate at 1, 2, 3, and 4 years was 96.8%, 52.7%, 24.0%, and 19.1%, respectively, for patients who underwent LITT; 77.3%, 50.2%, 30.8%, and 16.4%, respectively, for patients who underwent RFA; and 54.6%, 29.1%, 10.0%, and 1.0%, respectively, for patients who underwent MWA. The authors concluded there was no statistically significant difference noted among the three ablation methods.

Nour-Eldin et al. (2017) retrospectively compared laser-induced thermotherapy (LITT), radiofrequency ablation (RFA), and microwave ablation (MWA). A total of 175 computed tomography (CT)-guided ablation sessions were performed on 109 patients with surgically inoperable (non-colorectal cancer) pulmonary metastases who were poor candidates for surgery because of medical reasons including limited cardiopulmonary reserve, and had five or fewer lesions. Seventeen patients with 22 lesions underwent LITT treatment, 29 patients with 49 lesions underwent RFA, and 63 patients with 104 lesions underwent MWA treatment. Overall-survival rates showed no significant difference between LITT, RFA and MWA at log-rank test analysis (p=0.078). The 1- and 2-years of progression-free survival was 93.4 and 86.6% for MWA, 79.2 and 70.4% for LITT, and 89.4 and 68.2% for RFA. Statistically significant differences were seen in local tumour control and progression-free survival representing a potential advantage for MWA over RFA and LITT.

Tatsui et al. (2015) reported on 11 spinal metastasis patients with a high degree of epidural malignant compression due to radioresistant tumors who underwent spinal laser interstitial thermotherapy (SLITT) as an alternative to surgery. All patients received postoperative spinal stereotactic radiosurgery (SSRS). Median follow-
up was 4.7 months. Imaging follow-up two months after the procedure demonstrated a significant reduction in the mean thickness of the epidural tumor from 8.82 mm before treatment to 6.36 mm after SLITT and SSRS (p=0.0001). The authors proposed this procedure can be an alternative to separation surgery in patients without neurological deficits prior to SSRS, especially in cases with progressive systemic disease, in which conventional surgery would pose a high risk for complications and lead to an interruption of or delays in the delivery of the intended oncological treatment.

The American Board of Internal Medicine's (ABIM) Foundation Choosing Wisely® Initiative
No relevant information.

Use Outside of the US
There are several European Association for Neuro-Oncology (EANO) guidelines addressing gliomas; none address LITT/MRgLITT.

Coding/Billing Information

Note: 1) This list of codes may not be all-inclusive.
   2) Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement.

Considered Experimental/Investigational/Unproven:

<table>
<thead>
<tr>
<th>CPT® Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19499</td>
<td>Unlisted procedure, breast</td>
</tr>
<tr>
<td>27599</td>
<td>Unlisted procedure, femur or knee</td>
</tr>
<tr>
<td>32999</td>
<td>Unlisted procedure, lungs and pleura</td>
</tr>
<tr>
<td>55899</td>
<td>Unlisted procedure, male genital system</td>
</tr>
<tr>
<td>64999</td>
<td>Unlisted procedure, nervous system</td>
</tr>
</tbody>
</table>


References


4. American Association of Neurological Surgeons (See Congress of Neurological Surgeons.)


