



## Accurate Clinic

2401 Veterans Memorial Blvd. Suite 16  
Kenner, LA 70062 - 4799  
Phone: 504.472.6130 Fax: 504.472.6128

[www.AccurateClinic.com](http://www.AccurateClinic.com)

## Accurate Education

# Repetitive Transcranial Magnetic Stimulation (rTMS)

## A Comprehensive Overview

### What is rTMS?

**rTMS is a non-invasive brain stimulation technique that uses powerful magnetic pulses to modulate neuronal activity in specific brain regions.** [1] The procedure involves placing an electromagnetic coil on the scalp, which generates a magnetic field that penetrates the skull and induces electrical currents in underlying brain tissue. [1] These currents can alter neuronal excitability and promote beneficial changes in brain function without requiring surgery or anesthesia.

### How and Why rTMS May Work for Central Post-Stroke Pain

rTMS appears to work by restoring abnormal brain activity patterns and connectivity that develop after stroke. Multiple mechanisms likely contribute to pain relief:

- **Restoration of cortical excitability:** Studies show that patients with CPSP have abnormally high motor thresholds and reduced intracortical facilitation compared to healthy controls. [2] Responders to rTMS demonstrate significant increases in intracortical facilitation after treatment, suggesting that normalizing these abnormal excitability patterns may underlie pain relief. [2]
- **Modulation of brain connectivity:** Research in primate CPSP models demonstrates that stroke causes maladaptive strengthening of functional connections between the thalamus and emotion-processing regions like the amygdala. rTMS normalizes these inappropriately strengthened connections, which may explain its therapeutic effect. [3]
- **Neuroinflammatory and neuroplastic effects:** rTMS may reduce neuroinflammation by modulating immune responses and inflammatory cytokines, while simultaneously promoting neurogenesis, enhancing synaptic plasticity, and facilitating brain remodeling. [4][5] These effects align with your hypothesis about targeting neuroinflammation in CPSP.
- **Neurotransmitter modulation:** rTMS affects the release of pain-modulating neurotransmitters and alters structural and functional connectivity in brain regions involved in pain processing. [6]

### Treatment Protocols

For a patient two years post-stroke with refractory right-sided hemibody pain, high-frequency (10-20 Hz) rTMS targeting the left primary motor cortex (M1) represents the standard evidence-based approach. [7][8][9]

## Recommended Protocol Options:

- **Spaced session protocol** (strongest evidence): 4 sessions delivered at 3-week intervals, with each session consisting of 20 Hz stimulation over M1 using neuronavigation.[\[8\]](#) This protocol achieved 33.8% pain relief versus 13% with sham, with 47% of patients classified as responders.[\[8\]](#)
- **Intensive protocol**: 10 daily sessions over 2 weeks, delivering 5,050 pulses per session at 10 Hz.[\[10\]](#) This approach is more commonly studied but may be less practical for some patients.

## Key technical parameters:

- Target: Left M1 (contralateral to right-sided pain)
- Frequency: 10-20 Hz (high-frequency)
- Neuronavigation: Strongly recommended for precise targeting
- Motor threshold determination: Required at first session to establish safe, individualized stimulation intensity[\[11\]](#)

## Important Caveat About Timing

Subgroup analyses suggest that rTMS efficacy may be reduced in patients with CPSP duration exceeding 6 months.[\[9\]](#) One meta-analysis found no statistically significant benefit for pain duration beyond 6 months (SMD: -0.80; 95% CI: -1.63 to 0.03;  $p = 0.059$ ).[\[9\]](#) However, this does not preclude attempting treatment, as individual responses vary and some patients with chronic pain do respond.

## Alternative Target

**The secondary somatosensory cortex (S2) represents a promising alternative target,** particularly if M1 stimulation proves ineffective.[\[10\]](#) In one randomized trial, S2 stimulation resulted in  $\geq 30\%$  long-term pain reduction in 18% of patients, with a significant 15% pain relief at one-month follow-up.[\[10\]](#)

## Expected Outcomes

Meta-analyses demonstrate significant pain reduction with rTMS compared to sham stimulation:

- Large effect size: SMD -1.45 (95% CI: -1.87 to -1.03)[\[7\]](#)
- Moderate effect size: SMD -1.15 (95% CI: -1.69 to -0.61)[\[9\]](#)
- Average pain relief: 33.8% in active treatment versus 13% with sham[\[8\]](#)
- Responder rate: Approximately 47% achieve clinically meaningful pain reduction[\[8\]](#)

**Effects on quality of life, depression, and anxiety are less clear,** with most studies showing no significant impact on these secondary outcomes.[\[9\]](#) The primary benefit is pain reduction rather than broader functional improvements.

## Side Effects and Safety

rTMS has a favorable safety profile with mostly minor, transient side effects:[\[7\]\[11\]](#)

### Common minor effects:

- Transient headaches (most common)
- Local scalp discomfort at stimulation site
- Mild tingling sensations

### Rare serious effects:

- Seizures: Approximately 2 reported cases across multiple studies[1]
- Risk is minimized through proper screening and motor threshold determination

### Pre-Treatment Safety Screening

A comprehensive safety evaluation is essential before initiating rTMS.[11] The TMS Adult Safety Screen (TASS) or similar tools should identify:

- Personal/family history of epilepsy or seizures
- Past stroke or head injury with neurologic sequelae
- Medications that lower seizure threshold (e.g., stimulants) or recent dose reductions of anticonvulsants
- Sleep deprivation, electrolyte imbalances, or substance withdrawal
- Metallic implants in the head (excluding dental fillings)
- The procedure has been extensively studied specifically in stroke populations.

### Insurance Coverage with Medicaid

- **Medicaid coverage for rTMS in chronic pain conditions, including CPSP, is highly variable and generally limited.** Key considerations:
- **FDA approval status:** In the United States, rTMS is FDA-approved for depression, migraine prevention, and obsessive-compulsive disorder, but **pain management applications are considered investigational.**[1] This significantly impacts coverage.

### Coverage challenges:

- Most Medicaid programs do not routinely cover rTMS for pain conditions
- Coverage is most established for FDA-approved indications (primarily depression)
- Prior authorization would likely be required, with documentation of failed conventional treatments
- Some states may cover rTMS for pain under research protocols or exceptional circumstances

### Practical recommendations:

- Contact the patient's specific Medicaid plan to inquire about coverage policies for rTMS in chronic pain
- Document extensive trials of conventional therapies (anti-epileptics, antidepressants, opioids)
- Consider whether the patient has comorbid depression, which might provide an alternative coverage pathway
- Explore academic medical centers or research institutions that may offer rTMS for CPSP through clinical trials or reduced-cost programs

### Additional Relevant Information

- **Treatment duration and maintenance:** Most protocols involve 10-20 sessions for initial treatment.[7][8][10] The duration of pain relief varies, with some patients experiencing sustained benefits and others requiring maintenance sessions.
- **Predictors of response:** Lower baseline intracortical facilitation may predict better response to rTMS.[2] The DRD2 T/T genotype has been associated with M1 stimulation response, though this requires confirmation.[10] No reliable clinical predictors currently exist to identify responders before treatment.

- **Comparison to other neuromodulation:** If rTMS provides partial benefit, it may predict response to invasive motor cortex stimulation (MCS), though MCS carries surgical risks and has lower response rates specifically in post-stroke pain (approximately 45-50% at one year).
- **Quality of evidence:** Current evidence is rated as low to very low quality, primarily due to small sample sizes and heterogeneous protocols.<sup>[7][1]</sup> However, the consistency of findings across multiple trials supports clinical consideration for refractory cases.

## Key Points

1. **Non-invasive nature:** No surgery, anesthesia, or needles required
2. **Realistic expectations:** Approximately 47% of patients experience meaningful pain reduction; complete pain elimination is uncommon (< 6mon)
3. **Time commitment:** Requires multiple sessions over weeks to months
4. **Safety profile:** Generally well-tolerated with minimal side effects
5. **Insurance uncertainty:** Coverage may be limited; out-of-pocket costs should be discussed upfront
6. **Adjunctive approach:** rTMS would complement rather than replace current pain management strategies
7. **Chronicity consideration:** Two-year duration may reduce likelihood of response, though individual variation exists

**rTMS represents a reasonable evidence-based option to discuss**, particularly if available at a nearby academic center with expertise in neuromodulation for pain.

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