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INPLASY

# Comparative Efficacy of Low-Level Laser Therapy in Patients with Carpal Tunnel Syndrome: A Protocol for a Systematic Review and Meta-analysis

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## ADMINISTRATIVE INFORMATION

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**Review Stage at time of this submission -** Completed but not published.

**Conflicts of interest -** None declared.

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**Amendments -** This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 16 March 2026 and was last updated on 16 March 2026.

## INTRODUCTION

**Review question / Objective** To synthesize current evidence on low-level laser therapy (LLLT) for carpal tunnel syndrome (CTS), evaluating its effects on pain, grip strength, and electrophysiological outcomes while exploring treatment-related parameters to inform the development of clearer clinical protocols.

**Rationale** LLLT is a commonly used non-invasive physical therapy for mild to moderate CTS. It has been suggested to improve pain, grip strength, and electrophysiological parameters in several clinical studies. However, the reported clinical outcomes and optimal treatment parameters remain inconsistent across different trials. Therefore, we will perform an updated systematic review and meta-analysis to investigate the overall treatment effect of LLLT on CTS and systematically explore these potential treatment moderators to inform clearer clinical protocols.

**Condition being studied** The PICO (population, intervention, comparison, outcome) setting of the current meta-analysis will include: (1) Population: adults (≥18 years) with a confirmed diagnosis of CTS; (2) Intervention: LLLT; (3) Comparison: placebo laser, no treatment, or standard conservative care; and (4) Outcomes: changes in pain intensity, grip strength, median nerve cross-sectional area (CSA), sensory nerve conduction velocity (SNCV), and sensory distal latency (SDL).

## METHODS

**Search strategy** Two authors will make independent electronic searches in PubMed,

Embase, Cochrane CENTRAL, Web of Science and ClinicalTrials.gov with keywords of ('Carpal tunnel syndrome' OR 'Median nerve entrapment' OR 'Median neuropathy') AND ('Photobiomodulation' OR 'Low-level laser therapy' OR 'Low-intensity laser') through the earliest record to Dec 31, 2025.Two authors will make independent electronic searches in PubMed, Embase, Cochrane CENTRAL, Web of Science and ClinicalTrials.gov with keywords of ('Carpal tunnel syndrome' OR 'Median nerve entrapment' OR 'Median neuropathy') AND ('Photobiomodulation' OR 'Low-level laser therapy' OR 'Low-intensity laser') through the earliest record to Dec 31, 2025.

**Participant or population** Adults (≥18 years) diagnosed with CTS based on clinical symptoms or electrodiagnostic criteria.

**Intervention** LLLT.

**Comparator** Placebo laser, no treatment, or standard conservative care.

**Study designs to be included** Randomized controlled trials.

**Eligibility criteria** To generate a recruited study list, the following inclusion criteria will be used: (1) RCTs enrolling adults diagnosed with CTS based on clinical symptoms or electrodiagnostic criteria; (2) RCTs investigating the quantitative evaluation of outcomes before and after laser therapy; (3) studies administering LLLT either as a monotherapy or in combination with other conservative treatments, provided the co-intervention was consistent across groups; and (4) trials with available full-text data for extraction.

**Information sources** Two authors will make independent electronic searches in PubMed, Embase, Cochrane CENTRAL, Web of Science and ClinicalTrials.gov with keyword of ('Carpal tunnel syndrome' OR 'Median nerve entrapment' OR 'Median neuropathy') AND ('Photobiomodulation' OR 'Low-level laser therapy' OR 'Low-intensity laser') through the earliest record to Dec 31, 2025.

**Main outcome(s)** The primary outcome will be the change in pain intensity of the affected hand or wrist following LLLT or control interventions. Pain will be quantified using established instruments, including the Visual Analog Scale (VAS), Numeric Pain Rating Scale (NPRS), or Anchored Numeric Pain Rating Scale (ANPRS). For studies reporting outcomes at multiple follow-up time points, the data point closest to the end of the intervention period will be prioritized for the primary meta-analysis.The primary outcome will be the change in pain intensity of the affected hand or wrist following LLLT or control interventions. Pain will be quantified using established instruments, including the Visual Analog Scale (VAS), Numeric Pain Rating Scale (NPRS), or Anchored Numeric Pain Rating Scale (ANPRS). For studies reporting outcomes at multiple follow-up time points, the data point closest to the end of the intervention period will be prioritized for the primary meta-analysis.

**Additional outcome(s)** The secondary outcomes will encompass functional performance represented by grip strength, nerve morphology evaluated through median nerve cross-sectional area (CSA), and electrophysiological parameters including sensory nerve conduction velocity (SNCV) and sensory distal latency (SDL).

**Data management** Two independent authors will extract data from the recruited studies, encompassing participant demographics, study design, detailed parameters of the laser intervention (e.g., wavelength and mode) and control conditions, and values of the primary and secondary outcomes. The evaluators will pay special attention to the direction of effect for different scales used in each trial to avoid misinterpretation. In situations where the data is unavailable in the published articles, we will contact the corresponding authors to obtain the original data.

**Quality assessment / Risk of bias analysis** To investigate the methodological quality of recruited studies, we will use the Cochrane risk-of-bias tool for randomized trials, version 2 (RoB 2), which consists of 6 main items: randomization process, intervention adherence, missing outcome data, outcome measurement, selective reporting, and overall risk of bias. In the intervention adherence section of RoB 2, there are two options for literature assessment: intention-to-treat (intervention assignment) or per-protocol (intervention adherence). In this meta-analysis, we will choose the per-protocol evaluation, since it fits the design of our included studies.

**Strategy of data synthesis** Because of the heterogeneity of the target populations in the enrolled studies, the current meta-analysis will be conducted with a random-effects model, using Comprehensive Meta-Analysis software, version 3 (Biostat, Englewood, NJ). A two-tailed p value less than 0.05 will be considered statistically significant. We will choose Hedges' g and 95% confidence intervals (CIs) to quantify all continuous outcomes, including the primary outcome (changes in pain

intensity) and secondary outcomes (grip strength, median nerve cross-sectional area, sensory nerve conduction velocity, and sensory distal latency). A Hedges' g of 0.2, 0.5, and 0.8 is considered a small, moderate, and large effect size, respectively. The I-squared and Cochran's Q statistics will be used to evaluate the degree of heterogeneity among studies. An I-squared value of 25%, 50%, and 75% will be considered low, moderate, and high heterogeneity, respectively.

**Subgroup analysis** Subgroup analyses will be performed to examine differences in treatment effects based on specific LLLT regimens and control types. We will also investigate the influence of different laser emission modes, namely continuous and pulsed modes. Furthermore, meta-regression analyses will be conducted to examine whether the total number of treatment sessions and the laser wavelength serve as modifiers of the overall treatment effect.

**Sensitivity analysis** To confirm the robustness of the meta-analysis, the sensitivity analyses will be performed using one-study removal method to see if there is a significant change in the summary effect size after removing a particular trial from the analysis.

**Language restriction** No language limit.

**Country(ies) involved** Taiwan.

**Keywords** Carpal Tunnel Syndrome, Low-Level Laser Therapy, Photobiomodulation, Laser Therapy.

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