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A Comprehensive Review of Trigeminal Neuralgia Management: Evidence Synthesis and Future Directions for Acupuncture-Assisted Radiotherapy

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ABSTRACT

This scoping review synthesizes and visually maps evidence on trigeminal neuralgia (TN) treatments over the past decade, identifying research trends and evidence gaps.

Following PRISMA-ScR guidelines, we systematically searched PubMed, Embase, Scopus, and Web of Science from November 2015 to October 2025, including clinical studies on all TN treatment modalities.

Among 2,847 screened publications, 226 studies were included, comprising 29 randomized controlled trials (12.8%). Pharmacotherapy, predominantly carbamazepine, shows high short-term efficacy but is limited by adverse effects.

Surgical interventions, especially microvascular decompression and percutaneous balloon compression, dominate research. Stereotactic radiosurgery offers a non-invasive alternative with delayed onset and higher recurrence rates. Evidence for alternative therapies like acupuncture is emerging but constrained by small-scale studies.

A critical unmet need exists for minimally invasive strategies balancing sustained efficacy with reduced side effects. We propose a novel interdisciplinary paradigm combining radioneuromodulation with acupoint stimulation, warranting rigorous future trials.

INTRODUCTION

Trigeminal neuralgia is a neurological disorder characterized by recurrent, excruciating, electric shock-like pain within the trigeminal nerve distribution, severely impairing quality of life.

Current treatments include pharmacotherapy, surgery, and radiotherapy, each with distinct efficacy and safety profiles.

However, therapeutic decision-making remains complex due to heterogeneous outcomes and lack of consensus on optimal sequencing.

Given the broad scope of TN treatment and high heterogeneity in study designs, this scoping review systematically maps the overall landscape of therapeutic interventions, reveals research hotspots, identifies evidence gaps, and proposes innovative interdisciplinary future directions.

METHODS AND MATERIALS

Following the PRISMA-ScR guidelines and Arksey & O'Malley framework, we conducted a systematic search in PubMed, Embase, Scopus, and Web of Science from November 2015 to October 2025.

We included all clinical studies on any TN treatment modality. Two researchers independently screened literature and extracted data using a standardized form.

Discrepancies were resolved by a third reviewer. No formal quality assessment was conducted per scoping review methodology.

The PCC framework (Population, Concept, Context) guided inclusion criteria. Studies not in Chinese or English, case reports, systematic reviews, and meta-analyses were excluded.

Figure 1 Medicine

Figure 2 Surgical operation

Figure 3 Acupuncture

RESULTS

A total of 226 studies were included, consisting of 29 randomized controlled trials (12.8%), 155 retrospective studies (68.6%), and 42 prospective cohort studies (18.6%).

Pharmacotherapy, primarily carbamazepine, demonstrates high short-term efficacy but is limited by adverse effects and poor adherence.

Surgical interventions, particularly microvascular decompression and percutaneous balloon compression, dominate research output.

Stereotactic radiosurgery offers a non-invasive alternative with delayed onset and higher recurrence rates. Evidence for acupuncture and neuromodulation is emerging but constrained by small sample sizes and methodological heterogeneity.

The evidence map highlights a critical need for minimally invasive strategies that balance sustained efficacy with reduced side effects.

Figure 4 Literature selection process.

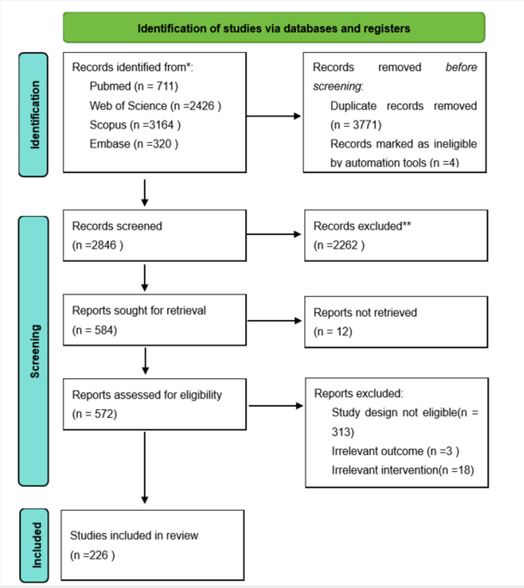
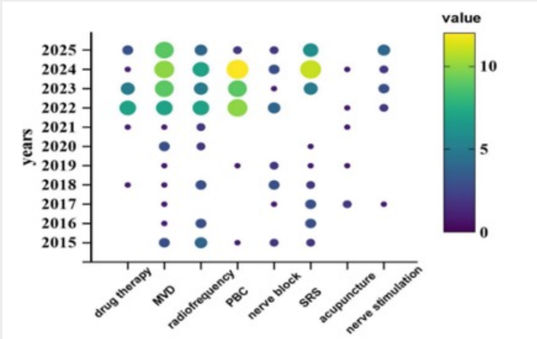


Figure 5 Bubble Chart of Research Outputs on Primary Clinical Treatment Methods for Trigeminal Neuralgia from 2015 to 2025



DISCUSSION

Current TN treatment faces a fundamental trade-off between efficacy and tolerability. Pharmacological therapy is limited by adverse effects, while surgical options like MVD offer durability but with invasiveness risks.

Radiosurgery provides non-invasive modulation but has delayed efficacy and recurrence. Alternative therapies such as acupuncture show promise but lack high-level evidence.

Based on mechanistic synergies, we propose a sequential integrated paradigm combining stereotactic radiosurgery with phased adjunctive acupuncture.

Radiosurgery precisely modulates nerve root activity, while acupuncture induces neuroendocrine-immune regulation and may mitigate side effects.

This interdisciplinary approach shifts the concept from neural destruction to neural functional remodeling, offering a novel pathway for refractory TN.

CONCLUSIONS

Current TN treatment is evolving toward diversification and minimally invasive approaches.

Based on mapped evidence and mechanistic synergies, we propose a novel interdisciplinary paradigm combining radioneuromodulation with acupoint stimulation.

This approach represents a conceptual shift from neural destruction to neural functional remodeling.

Future research must prioritize rigorous, large-scale clinical trials to validate this paradigm and foster cross-disciplinary collaboration to develop more effective, safer, and patient-centered therapies for trigeminal neuralgia.

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