RESEARCH PAPER

Comparison of Oxcarbazepine and Carbamazepine in Management of Trigeminal Neuralgia: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Trigeminal neuralgia (TN) is a chronic neuropathic facial pain syndrome for which antiepileptic drugs remain the cornerstone of pharmacological management. Carbamazepine (CBZ) has long been considered the first-line therapy due to its established efficacy, but its adverse effect profile can limit tolerability. Oxcarbazepine (OXC), a keto-analogue of CBZ, has been increasingly utilized as a potential alternative with comparable efficacy and improved safety.

Objective: To systematically compare the efficacy, tolerability, and safety of oxcarbazepine versus carbamazepine in adult patients with trigeminal neuralgia.

Methods: A systematic review was conducted of studies directly comparing OXC and CBZ in TN, including randomized controlled trials (RCTs) and observational cohort studies identified through PubMed, Scopus, ScienceDirect, and Google Scholar (January 2013 – July 2024). Primary outcomes were pain reduction (Visual Analogue Scale) and response rates; secondary outcomes included frequency and severity of adverse effects. A meta-analysis was performed on studies reporting comparable quantitative outcomes.

Results: Four studies (n = 646 patients) were included. Pooled meta-analysis demonstrated a statistically significant mean VAS difference of −1.59 (95% CI: −2.51 to −0.67; p = 0.0007) favoring OXC. OXC was consistently associated with a lower incidence of adverse events (30.3%) compared with CBZ (43.6%; $p < 0.05$), particularly central nervous system and hematologic toxicities.

Conclusions: Oxcarbazepine offers pain-relieving efficacy similar to or superior to carbamazepine while providing a more favorable tolerability profile, supporting its consideration as a first-line alternative in the management of trigeminal neuralgia. Larger, high-quality RCTs with standardized outcome measures are warranted.

Keywords: *Trigeminal neuralgia; Carbamazepine; Oxcarbazepine; Systematic review; Meta-analysis; Neuropathic pain; Efficacy; Tolerability*

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INTRODUCTION

Trigeminal neuralgia (TN) is a debilitating craniofacial pain condition characterized by sudden, severe, electric-shock-like episodes of pain along one or more branches of the trigeminal nerve (cranial nerve V).[1] The prevalence is estimated at approximately 4–13 per 100,000 persons annually, with increasing incidence with age and female predominance. The pathophysiology involves focal demyelination at the trigeminal root entry zone, typically secondary to neurovascular compression, leading to ectopic impulse generation and ephaptic cross-excitation of trigeminal afferents. The extreme nature of the pain has profound implications for quality of life, eating, speaking, and psychosocial well-being; thus, effective management is imperative.[2]

Pharmacotherapy remains the first-line approach for TN before surgical or device-based interventions. Historically, the antiepileptic drug carbamazepine (CBZ) has been considered the gold-standard pharmacological treatment, with multiple trials demonstrating significant pain reduction and decreased pain-attack frequency.[3] Clinical guidelines from the American Academy of Neurology (AAN) and the European Federation of Neurological Societies (EFNS) endorse CBZ as the preferred initial medication. However, despite its efficacy, CBZ is associated with a range of adverse effects, including central nervous system (CNS) sedation, dizziness,

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cognitive impairment, hyponatremia, hepatic enzyme induction, and rare but serious hypersensitivity reactions such as Stevens–Johnson syndrome. These side effects and drug-interaction burdens may limit tolerability and long-term adherence, necessitating exploration of alternative pharmacological agents.[4,5]

Oxcarbazepine (OXC), a keto-analogue of CBZ, is converted to its active metabolite 10-monohydroxycarbazepine (MHD) via cytosolic reduction. OXC acts similarly to CBZ by blocking voltage-gated sodium channels, thereby reducing neuronal excitability, but exhibits fewer interactions with the cytochrome P450 system and a potentially superior adverse-effect profile.[6] Real-world evidence indicates that adverse-effect-related discontinuation occurred in approximately 30% of patients on OXC versus 43% on CBZ ($p < 0.0001$) in a large retrospective cohort.7 Furthermore, meta-analytic data suggest significantly fewer adverse events in favor of OXC (OR 2.35; 95% CI 1.51–3.67; $p = 0.0002$), while efficacy appears comparable (OR 0.52; 95% CI 0.13–2.04; $p = 0.35$).8,9

Given the debilitating nature of TN and the importance of balancing efficacy with safety, a direct, up-to-date systematic comparison of CBZ versus OXC is both timely and clinically relevant. The aims of this review were to: (1) systematically examine available evidence comparing the efficacy and tolerability of CBZ versus OXC in the management of TN; (2) synthesize outcomes regarding pain relief, responder rates, and adverse events; and (3) identify gaps in the literature with implications for clinical practice.

Review Question: Does oxcarbazepine demonstrate superior efficacy and tolerability compared to carbamazepine in patients with trigeminal neuralgia?

MATERIALS AND METHODS

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Prospero registration ID – CRD42024575618).

Eligibility Criteria

Study eligibility was defined using the PICOS framework:

- **Population:** Adult patients (aged 20–65 years) with a confirmed diagnosis of trigeminal neuralgia.
- **Intervention:** Oxcarbazepine (OXC).
- **Comparator:** Carbamazepine (CBZ).
- **Outcomes:** Pain relief (VAS scores), response rates, adverse event frequency and severity, and treatment discontinuation.
- **Study Design:** Randomized controlled trials (RCTs), quasi-experimental studies, prospective and retrospective comparative cohort studies.

Inclusion criteria comprised peer-reviewed articles published in English from January 2013 to July 2024. Exclusion criteria included: non-English publications; narrative reviews; conference proceedings; letters to the editor; and short communications.

Information Sources and Search Strategy

A comprehensive literature search was conducted across PubMed/MEDLINE, Scopus, ScienceDirect, and Google Scholar. MeSH terms and free-text keywords were combined using Boolean operators. Primary keywords included: “trigeminal neuralgia,” “Fothergill disease,” “tic douloureux,” “oxcarbazepine,” “OXC,” “Trileptal,” “carbamazepine,” “CBZ,” “Carbetrol,” and “Epitol.” Secondary terms included “neuropathic pain,” “efficacy,” “tolerability,” “adverse effects,” and “patient-related outcomes.” The reference lists of all included studies were hand-searched for additional relevant citations, and subject matter experts were consulted to identify grey literature.

Study Selection and Data Extraction

Two reviewers independently screened titles and abstracts, followed by full-text assessment of eligible articles. Discrepancies were resolved by consensus discussion. Duplicate removal was performed using Rayyan QCRI software. A standardized data extraction form (Microsoft Excel 2013) was used to capture: study identifier, author(s), year, country, study design, sample size, patient demographics, drug dosages, follow-up duration, primary outcomes, and study conclusions.

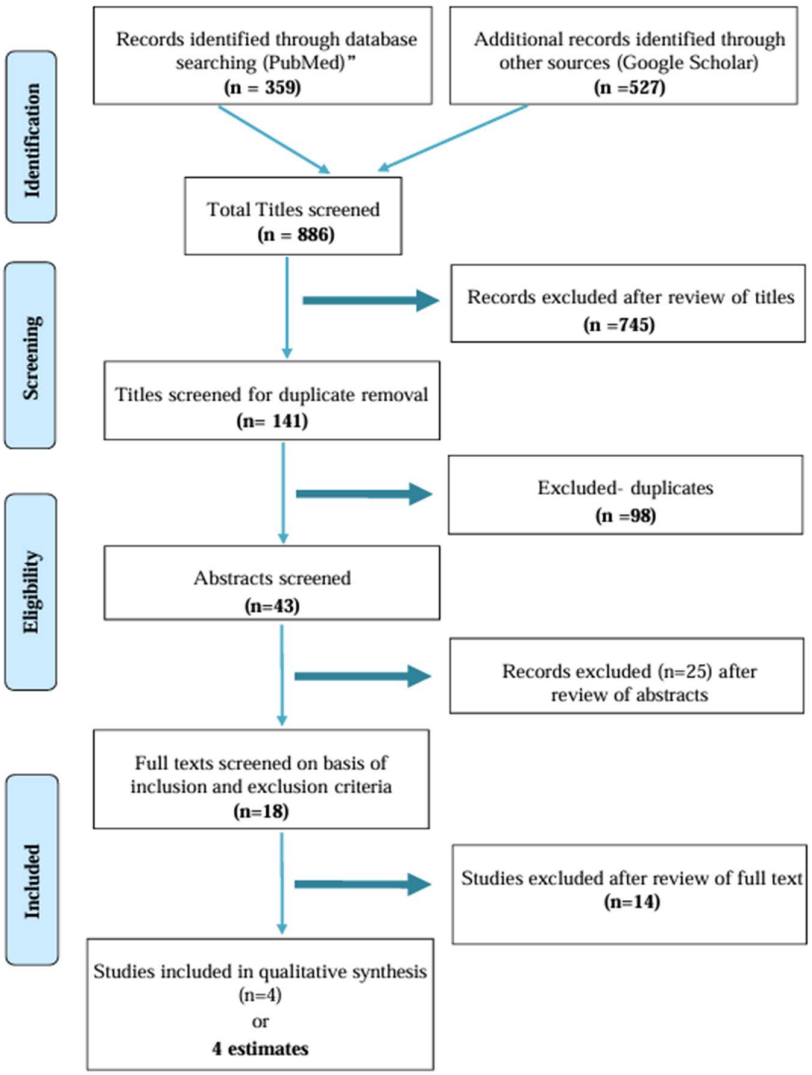

Figure 1: PRISMA flow chart presenting the screening process

Risk of Bias Assessment

Risk of bias was assessed using the Risk-of-Bias Visualization (ROBVIS) tool. The Cochrane RoB 2 tool was applied to the RCT. The ROBINS-I tool was used for non-randomized comparative studies, and the Newcastle-Ottawa Scale (NOS) was applied to retrospective and prospective cohort studies.

Statistical Analysis

Quantitative synthesis was performed for studies reporting mean VAS pain scores with standard deviations. Given the high heterogeneity (I^2 = 87%), a random-effects model (inverse variance method) was employed. Results are presented as mean differences (MD) with 95% confidence intervals. Publication bias was assessed via visual inspection of funnel plots.

RESULTS

The initial database search retrieved 886 records (PubMed: 359; Google Scholar: 527). After duplicate removal (n = 98) and title screening, 141 records remained. Abstract review excluded a further 25 records, leaving 18 full-text articles for eligibility assessment. Of these, 14 were excluded (wrong comparator, insufficient data, or not meeting study design criteria), and four studies were included in the final qualitative synthesis and meta-analysis. The complete selection process is depicted in the PRISMA flow diagram (Figure 1).

The four included studies were published between 2014 and 2025, involving a combined sample of 646 patients with confirmed TN. Two studies were conducted in Italy (Di Stefano G et al., 2014 and 2021) and two in Pakistan (Paiker S et al., 2024; Ahmad RM et al., 2025). Study designs comprised two retrospective cohort studies, one quasi-experimental prospective study, and one RCT. Sample sizes ranged from 70 to 354 participants. Table 1 summarizes the included studies; Table 2 details participant characteristics, interventions, and results.

Table 1. Details of included studies

Study ID	Author	Year	Location	Study Design	Sample Size
1	Di Stefano G et al.	2014	Rome, Italy	Retrospective cohort	n = 100 (last 100 consecutive TN patients on CBZ; last 100 on OXC)
2	Di Stefano G et al.	2021	Rome, Italy	Retrospective, real-world cohort	n = 354 (classical 254; secondary 60; idiopathic 40)
3	Paiker S et al.	2024	Pakistan (single center)	Quasi-experimental, prospective	n = 70 (Group A: CBZ = 35; Group B: OXC = 35)
4	Ahmad RM et al.	2025	Pakistan	Randomized controlled trial	n = 122 (Group A: OXC = 61; Group B: CBZ = 61)

Table 2. Participant characteristics, interventions, comparators, and outcomes

Author (Year)	Intervention (OXC)	Comparator (CBZ)	Follow-up	Primary Outcome	Key Results
Di Stefano G et al. (2014)	OXC median 1,200 mg (range 600–1,800 mg)	CBZ median 600 mg (range 200–1,200 mg)	Mean 8.6–13 months; 6-monthly reviews	Responder rates; treatment discontinuation due to side effects	3/100 patients developed drug resistance on CBZ; comparable resistance on OXC. Pain paroxysm intensity worsened in 3% on disease course. No clinically manifest sensory deficit observed.
Di Stefano G et al. (2021)	OXC range 300–1,800 mg	CBZ range 200–1,200 mg	4–6 monthly follow-up intervals	Side-effect frequency; refractoriness rates	Side effects occurred more frequently with CBZ (43.6%) than OXC (30.3%; $p < 0.05$). No significant difference in refractoriness.
Paiker S et al. (2024)	OXC 300 mg BD up to 1,800 mg/day	CBZ 200 mg BD up to 1,800 mg/day	6 months (VAS at 1st and 2nd month)	VAS pain scores	At 2nd-month follow-up: OXC mean VAS 3.1 ± 0.8 vs. CBZ 5.14 ± 0.8; $p < 0.001$, statistically significant.
Ahmad RM et al. (2025)	OXC 150 mg BD up to 1,800 mg/day	CBZ 100 mg BD up to 1,200 mg/day	6 months	VAS pain scores; response categorization (good/moderate/unresponsive)	OXC mean VAS 2.6 ± 1.2 vs. CBZ 3.7 ± 1.89; $p = 0.001$. OXC demonstrated significantly greater pain relief and higher proportion of good responders.

Risk of Bias Assessment

The RoB 2 assessment of the RCT (Ahmad RM et al., 2025) revealed low risk of bias across all five domains (Figure 2a, 2b). The ROBINS-I assessment of the three non-randomized studies demonstrated low risk of bias across all seven domains, with the exception of the "deviations from intended interventions" domain, which lacked sufficient information in two studies (Figure 3a, 3b). The Newcastle-Ottawa Scale assessment of the three cohort studies yielded scores of 6–7 out of 9; primary limitations included inadequate diagnostic verification, imprecise control definition, and insufficient adjustment for potential confounders (Table 3).

Table 3. Newcastle-Ottawa Scale quality assessment of included cohort studies

S.No.	Author (Year)	Year	Selection (Max ****)	Comparability (Max **)	Exposure / Outcome (Max ***)	Total Score
1	Di Stefano G et al.	2014	***	**	*	6/9
2	Di Stefano G et al.	2021	***	**	**	7/9
3	Paiker S et al.	2024	***	**	**	7/9

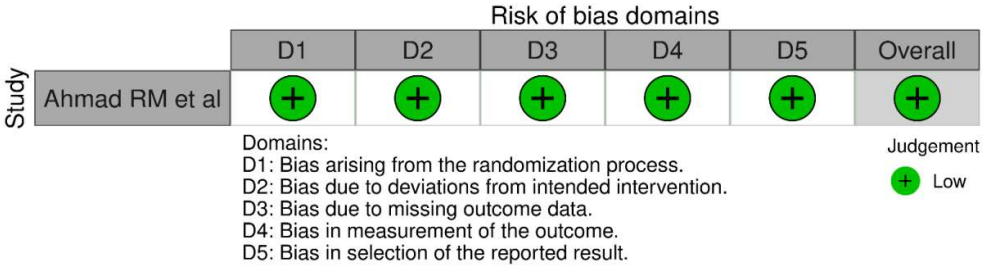

Figure 2a: Risk of bias traffic light plot using RoB-2 tool

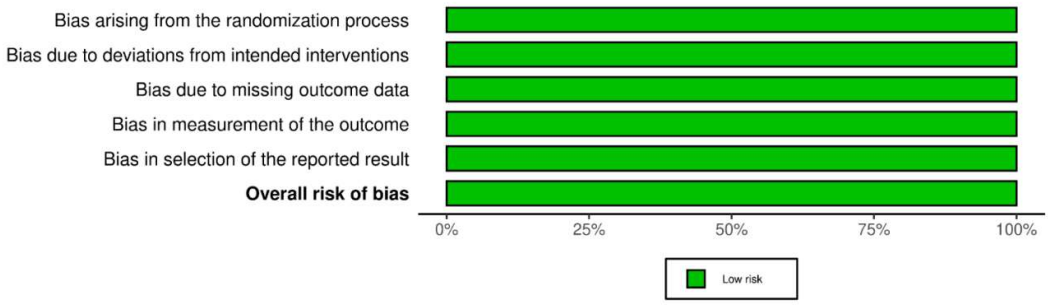

Figure 2b: RoB2 "Summary Plot" distribution of risk of bias among the studies

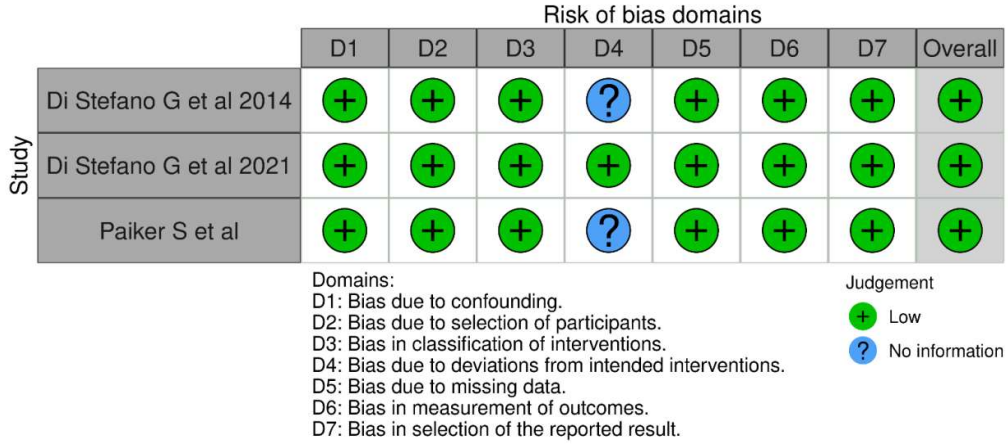

Figure 3a: Risk of bias traffic light plot using ROBINS I tool

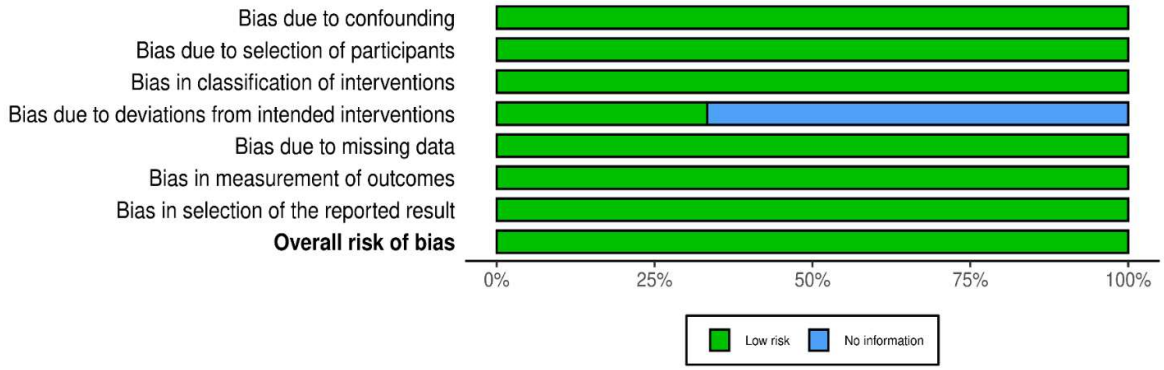

Figure 3b: ROBINS I "Summary Plot" distribution of risk of bias among the studies

Two studies (Ahmad RM et al., 2025 and Paiker S et al., 2024) reported comparable quantitative VAS outcomes and were included in the meta-analysis (n = 192 total; 96 per group). High inter-study heterogeneity was detected (I^2 = 87%; χ^2 = 7.44, df = 1, p = 0.006); accordingly, a random-effects model was applied.

The pooled mean difference (MD) in VAS pain scores between OXC and CBZ was −1.59 (95% CI: −2.51 to −0.67; Z = 3.40, p = 0.0007), statistically significant and favoring OXC (Figure 4). Table 4 presents the individual and pooled VAS data.

Table 4. Quantitative data: mean VAS scores in OXC (intervention) and CBZ (control) groups.

Sr.	Study	OXC Mean	OXC SD	OXC N	CBZ Mean	CBZ SD	CBZ N	p
1	Ahmad RM et al. (2025)	2.6	1.2	61	3.7	1.89	61	0.001
2	Paiker S et al. (2024)	3.1	0.8	35	5.14	0.8	35	<0.001
Pooled (Random Effects)	—	—	**96**	—	—	**96**	**0.0007**	

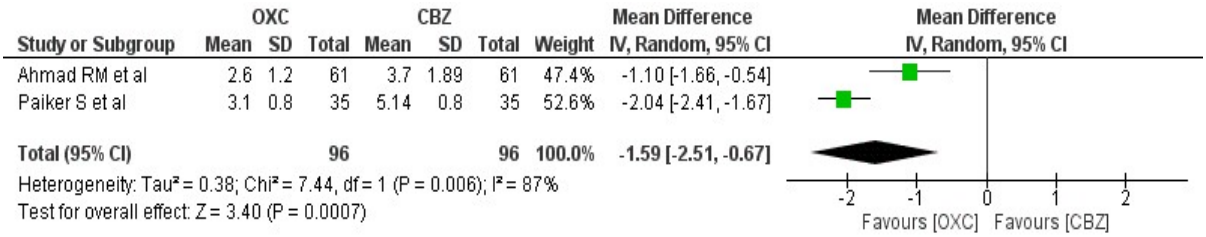

Figure 4: Forest Plot Distribution for outcome: Mean VAS scores

Across the observational studies, side effects occurred significantly more frequently in patients receiving CBZ (43.6%) than those receiving OXC (30.3%; p < 0.05). CBZ-associated adverse events included CNS effects (dizziness, drowsiness, cognitive impairment), hyponatremia, and hematologic changes. OXC was associated with a lower overall adverse-event burden, although hyponatremia remained a concern, particularly in elderly patients.

Visual inspection of the funnel plot (Figure 5) demonstrated approximate symmetry, with both included studies falling within the 95% CI diagonal lines, suggesting no significant publication bias in the quantitative synthesis.

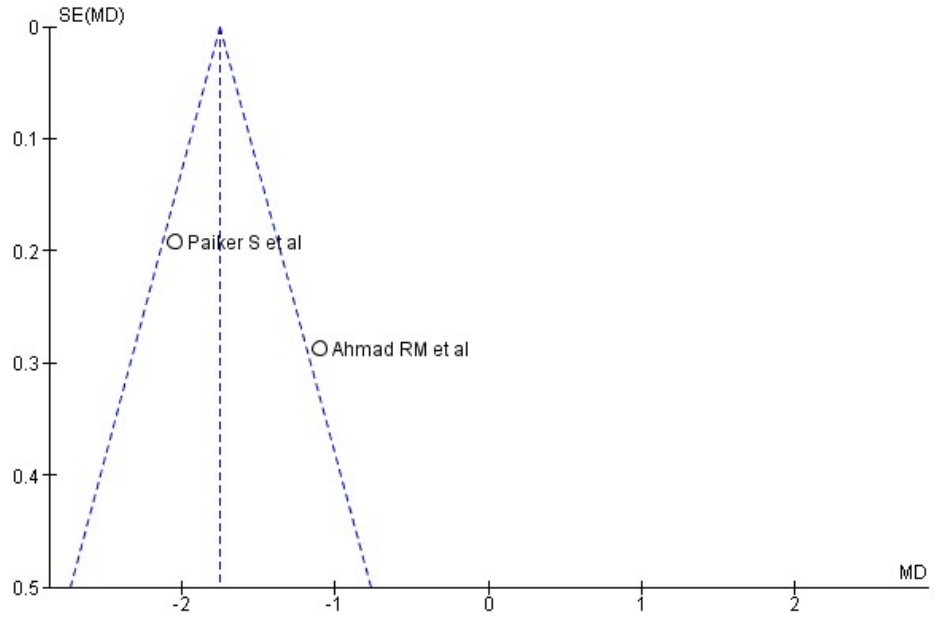

Figure 5: Funnel plot showing absence of publication bias in the studies for VAS scores

DISCUSSION

The results of this systematic review and meta-analysis demonstrate that both carbamazepine and oxcarbazepine are effective first-line pharmacological agents for trigeminal neuralgia. The pooled analysis of VAS scores revealed a statistically significant advantage for OXC over CBZ (MD −1.59; 95% CI −2.51 to −0.67; p = 0.0007), while the rate of treatment-limiting adverse events was consistently lower for OXC across all included studies.

These findings are consistent with prior systematic reviews. Mendieta et al. (2023) similarly reported comparable analgesic efficacy between the two agents, alongside significantly fewer adverse events with OXC.5 The pivotal work of Zakrzewska and Patsalos first established OXC as an effective alternative for patients intolerant or refractory to CBZ, and this conclusion has been reinforced by subsequent clinical evidence.8 In the large real-world cohort by Di Stefano et al. (2021; n = 354), treatment discontinuation due to side effects occurred in 43.6% of CBZ-treated patients versus 30.3% in OXC-treated patients, a clinically meaningful difference that supports preferential selection of OXC in susceptible populations.[7]

The observed tolerability advantage of OXC is largely attributable to pharmacokinetic differences. CBZ undergoes extensive hepatic metabolism via cytochrome P450 (CYP3A4) induction, generating the pharmacologically active epoxide metabolite (CBZ-10,11-epoxide) implicated in many systemic adverse effects.[10] In contrast, OXC is bio transformed to MHD via cytosolic reductases, largely bypassing CYP450 induction, resulting in more predictable plasma concentrations, reduced drug–drug interactions, and a lower burden of CNS and hematological toxicity.[6,12] This pharmacokinetic profile renders OXC particularly advantageous in elderly patients and those receiving polypharmacy regimens including anticoagulants, antidepressants, or antipsychotics.

Despite the pharmacokinetic differences, both agents share a common mechanism of action: use- and voltage-dependent blockade of neuronal sodium channels, stabilizing hyperexcited neural membranes and attenuating ectopic discharge within demyelinated trigeminal afferents. This mechanistic similarity explains their comparable analgesic efficacy.[11] The absence of a meaningful difference in refractoriness rates between the two drugs in the Di Stefano studies further corroborates this pharmacodynamic equivalence.

Strengths and Limitations

The strengths of this review include adherence to PRISMA guidelines, the use of validated risk-of-bias tools (RoB 2, ROBINS-I, NOS), and inclusion of both RCT and real-world evidence to enhance generalizability. The RCT included (Ahmad RM et al., 2025) demonstrated low risk of bias across all domains, providing a high-quality anchor for the meta-analysis.

Nevertheless, several limitations must be acknowledged. First, only four studies met eligibility criteria, limiting statistical power and the ability to draw firm conclusions from pooled analyses. Second, substantial inter-study heterogeneity was detected (I^2 = 87%), necessitating a random-effects model; the sources of heterogeneity (differences in dosing regimens, patient populations, TN subtypes, and follow-up durations) could not be fully explored via subgroup analysis given the small number of studies. Third, most non-randomized studies are susceptible to selection bias, as patients switched to OXC frequently had prior intolerance to CBZ, which may inflate OXC"s apparent tolerability advantage. Fourth, inconsistent adverse-event reporting across studies —

including the use of non-validated symptom inventories — complicates pooled comparison. Fifth, the search was restricted to English-language publications from 2013 onwards, potentially introducing language and temporal bias.

Clinical Implications

While CBZ remains the guideline-endorsed first-line therapy for TN, the evidence reviewed herein supports OXC as a clinically rational and often preferable alternative, particularly in: patients experiencing intolerable CNS or hematologic side effects on CBZ; elderly patients or those on complex medication regimens in whom minimizing pharmacokinetic interactions is a priority; and patients at elevated risk of hepatic enzyme induction. Clinicians should exercise vigilance regarding OXC-related hyponatremia, particularly in older adults or those receiving diuretics, and monitor serum sodium levels regularly during therapy. In resource-limited settings, the lower cost and wider availability of generic CBZ may preserve its practical priority; however, the incremental cost of OXC may be justified when accounting for reduced adverse-event burden and improved adherence.

Future Research Directions

Future investigations should priorities large, multicenter RCTs with standardized diagnostic criteria (distinguishing classical from secondary and idiopathic TN), consistent dosing protocols, and validated outcome instruments. Longitudinal cohort studies with extended follow-up (≥12 months) are needed to characterize relapse rates, sustained efficacy, and cumulative toxicity. Comparative pharmacogenomic studies exploring CYP3A4 polymorphisms and HLA-B*1502 associations with hypersensitivity could further guide personalized therapy. Finally, head-to-head cost-effectiveness analyses incorporating quality-adjusted life years (QALYs) would inform healthcare policy and reimbursement decisions.

CONCLUSION

Within the limitations of this systematic review and meta-analysis, both carbamazepine and oxcarbazepine are effective pharmacological agents for trigeminal neuralgia. Pooled quantitative evidence demonstrates a statistically significant superiority of OXC over CBZ in pain reduction as measured by VAS scores (MD −1.59; 95% CI −2.51 to −0.67; p = 0.0007), alongside a consistently lower adverse-event burden (30.3% vs. 43.6%). Given these findings, oxcarbazepine should be considered a clinically viable alternative — and potentially preferred — first-line agent, particularly in patients with poor tolerance or contraindications to carbamazepine. Continued high-quality comparative research, including large RCTs with standardized outcome measures, is essential to refine patient selection criteria and optimize long-term management strategies for trigeminal neuralgia.

DATA AVAILABILITY DECLARATION:

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The dataset is not publicly available due to participant confidentiality and institutional data governance policies

CONFLICTS OF INTEREST:

The authors declare that they have no conflicts of interest.

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