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CONSTRAINT-INDUCED APHASIA THERAPY AND QUALITY OF LIFE IN POST-STROKE PATIENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT
Background: Aphasia is a common stroke complication that significantly impacts patients' quality of life (QoL). While Constraint-Induced Aphasia Therapy (CIAT) has been found to improve language capacity, its impact on QoL remains uncertain. **Objectives:** The purpose of the present study was to meta-analyze and systematically review the impact of CIAT on post-stroke aphasic patients' quality of life. **Methods:** A thorough search of five databases (PubMed, CINAHL, ScienceDirect, Scilit, and Cochrane Library) was conducted for 2009-2024 literature. Studies included experimental studies with assessments of CIAT's effect on QoL using valid instruments. Risk of bias was assessed using RoB 2 and JBI tools. Meta-analysis was conducted using Review Manager 5.4 and studies that utilized the SAQOL-39 scale. **Results:** Six trials were included based on inclusion criteria; three trials were subjected to the meta-analysis. CIAT had significant trends favorable for improved QoL, especially in areas of communication, although the combined effect was not significant statistically (MD = 0.11; 95% CI: –0.14 to 0.35; p = 0.40). There was low heterogeneity (I^2 = 0%). **Conclusion:** CIAT may enhance QoL in aphasia patients, particularly in communicative functioning. While lacking high statistical significance, outcomes are in favor of CIAT's role in neurorehabilitation. Additional high-quality trials would be needed to ensure these results.

INTRODUCTION

Aphasia is an acquired language disorder following stroke and one of the most common functional impairments associated with stroke[1]. Approximately 40–60% of stroke survivors have aphasia in the chronic phase, and it is correlated with increased dependence in activities of daily living, reduced social participation, poorer rehabilitation outcomes, and reduced quality of life[1–5].

Conventional therapy for aphasia has traditionally focused on compensatory communication strategies to bridge patients' short-term communication deficits. These multimodal approaches are based on the assumption that utilization of alternative modes will gradually diminish as oral language improves. While these strategies enhance overall communicative effectiveness, there remains debate about whether they actively promote language recovery or instead perpetuate a cycle of learned non-use[6].

As a response to this problem, treatment based on communicative restraint has been developed, adopting constraint-induced motor treatment. Constraint-Induced Aphasia Therapy (CIAT) addresses this by promoting intense exercise of speaking with verbal prompting, while deliberately excluding access to compensatory techniques previously employed by the patient[7,8]. Restriction of the use of an intact limb in the course of motor rehabilitation is relatively straightforward[9,10], but inhibition of nonverbal communication poses a difficulty.

CIAT adapts Taub's theoretical model of use-dependent cortical reorganization, originally developed for motor rehabilitation, to a language-based environment[9]. In this model, normal failed attempts at verbal communication can lead to

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frustration, decreasing the motivation of the patient to speak. This increases the dependence upon compensatory strategies and results in lessened activation of brain areas that are responsible for language.

CIAT challenges this cycle with a systematic and supportive setting of therapy that includes clinician-monitored practice, social reinforcement by peers, and exposure to social interaction. The hypothesis for this is that such a setting promotes increased verbal engagement, which is known to increase cortical currently available for the impact of CIAT on poststroke aphasia patients' quality of life and examine variables that may influence its outcome.

reorganization and support language recovery[11]. Some studies have established that CIAT enhances language function in individuals with chronic aphasia[9,10,12-17]. However, its effects on broader outcomes in patients, especially on quality of life (QoL), are still rarely reported. Since QoL is not only reflected in linguistic abilities but also in social interaction and independence, research on aphasia should not only focus on language dysfunction[18].This study was aimed to systematically review evidence

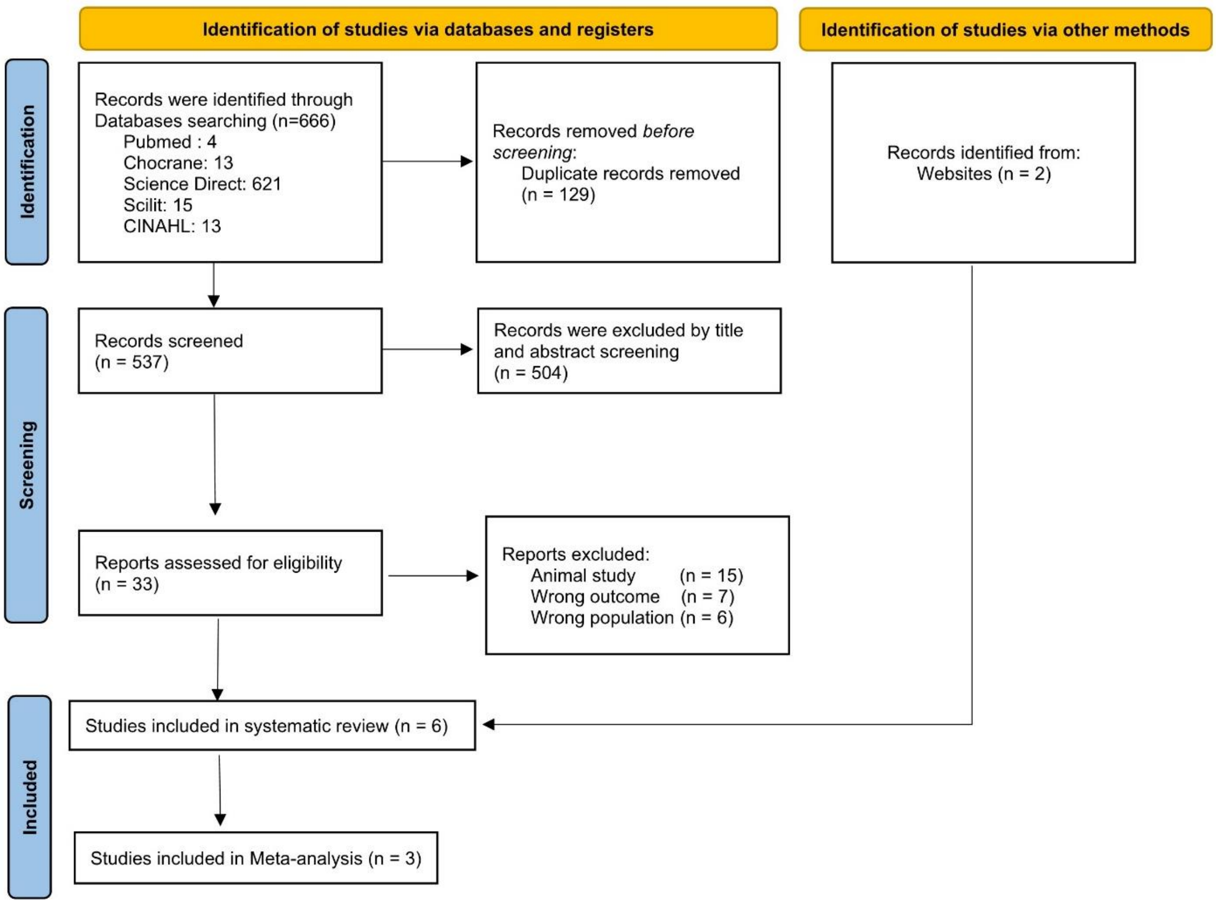

Figure 1. PRISMA Diagram

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METHODS

Search strategy

Five computerized databases, including PubMed, Cinahl, ScienceDirect, Scilit, and the Cochrane Library, were searched for studies published from 2009 up to 2024. The search used the following terms: ("constraint-induced aphasia therapy" OR CIAT OR "constraint induced language therapy" OR CILT) AND ("quality of life" OR QoL OR "life quality" OR "health-related quality of life" OR HRQoL) AND (aphasia OR "language impairment" OR "speech disorder" OR "post-stroke aphasia"). This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[19]. The articles obtained were screened and identified using Rayyan, a web-based system developed to facilitate the systematic review process[20]. Additionally, the reference lists of included studies were hand-searched for any additional relevant articles that met the inclusion criteria[21].

Eligibility Criteria

Studies included in this review were selected according to the following criteria: 1) employed an experimental or quasi-experimental design; 2) compared the effects of CIAT as the main treatment; 3) Adult participants (≥18 years) with poststroke aphasia; 4) assessed reported QoL as an outcome, using reliable measures such as the Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39), EuroQol (EQ-5D), or other appropriate QOL scales; 5) reported quantitative pre- and/or post-intervention QOL results;.

Exclusion criteria included: 1) studies combining CIAT with other therapies without isolating its impact, like pharmacological treatments or neuromodulation; 2) qualitative studies (narrative review or case reports); 3) non-reporting of any quantitative QoL outcomes; 4) pediatric groups, animals, or in vitro; 5) conference abstracts and protocols, with no full-text data.

Data Extraction and Quality Assessment

From each study included, the following data were extracted: first author's surname, year of publication, country of origin, study design, sample size, participant characteristics (age, sex, time post-stroke), CIAT protocol, and type of intervention (length, intensity, group size), control or comparison group type, and outcome measures for quality of life (instrument used, pre- and post-treatment scores, and statistical results).

For measuring methodological quality, two tools were employed depending on the study design. In the case of randomized controlled trials, the Cochrane Risk of Bias 2 (RoB 2)[22] tool was employed to rate five domains: randomization process, departures from intended interventions, missing outcome data, measurement of outcomes, and selection of the reported results. Risk of bias was rated as "low risk," "some concerns," or "high risk."

For non-randomized trials, the Joanna Briggs Institute (JBI) Critical Appraisal Checklist[23] was used, which grades studies based on criteria such as participant selection, clarity of intervention, outcome measurement, and completeness of follow-up. Studies that met at least 7 of the checklist criteria were considered high quality

Each quality rating was carried out independently by two reviewers, with agreement regarding any disagreement by discussion between reviewers or by reference to a third reviewer.

Statistical Analysis

Meta-analyses were performed on Review Manager (RevMan) version 5.4 (The Cochrane Collaboration, Oxford, UK)[24], following the methodological recommendations of the Cochrane Handbook for Systematic Reviews of Interventions[25]. Quantitative analysis was limited to studies for which the Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39) was the outcome measure.

Since all studies used the same instrument (SAQOL-39) to measure quality of life[26], and the scale design was the same, effect size was estimated using the mean difference (MD) with 95% confidence intervals (CIs). Where both pre- and post-treatment scores were published in studies, net change was calculated directly. Where studies offered more than one follow-up time point, the final measurement was used to capture the long-term impact of the intervention.

For outcomes provided in graphical only, numerical values were extracted using WebPlotDigitizer software. Meta-analyses were conducted using the inverse-variance method with random-effects model, so that intended clinical and

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methodological heterogeneity between studies could be adjusted for.

Statistical heterogeneity was assessed by the Chi-squared (χ^2) test, Tau^2, and I^2 statistic, and I^2 values of more than 50% were used to suggest considerable heterogeneity.

RESULTS

Search Results

We identified 666 records through database searching and 2 studies from other sources. After the exclusion of 129 duplicate records, 537 articles were titled and abstract screened. Out of them, 504 records were not relevant to the research question and were excluded, as shown in Figure 1. Full-text screening of the remaining 33 articles was conducted to assess their eligibility. Ultimately, 6 studies were included in the systematic review, and 3 were eligible for meta-analysis.

Characteristics of the Studies

The six studies covered in this review are outlined in Table 1, showing their main characteristics. Geographically, the majority of the studies were from Australia (n = 4), with the two others being from the United States. Three were randomized controlled trials (RCTs) in terms of study design, namely[27-29]. The remaining research included a pilot study[30], a single-subject design study[31], and a quasi-experimental comparative study[32].

Sample sizes ranged from one participant in the pilot study to 216 participants in a large RCT. All studies included adults with chronic or post-acute aphasia secondary to stroke. Interventions were CIAT or CIAT-Plus based, with variation in intensity, session length, and mode of delivery. Most interventions were delivered over a period of 2 to 5 weeks, with a total dose of therapy ranging from 20 to 30 hours.

The QoL was assessed using a range of standardized instruments, including the SAQOL-39, EQ-5D/QALY, ASHA-QCL, and Quality of Life Scale (QOLS). The trials reported variable findings for QoL change. Three studies[29,30,32], reported significant changes in QoL, especially in communication domains. One study[27] reported improvement in both groups but not significantly different. One study[28] reported no significant change in QoL, but scores remained stable. On the other hand, one study[32] observed language improvement subsequent to CIAT but not in concomitant QoL score improvements.Conflicting results are due in part to the heterogeneity in study design, intervention protocols, and outcome measurements, pointing to the need for more high-quality trials to establish more conclusive evidence of QoL benefit

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Table 1. Characteristics of Included Studies

Author (Year)	Country	Study Design	Sample Size	Population Characteristics	Intervention (CIAT)	Control / Comparison	Duration of Intervention	QoL Measure	QoL Outcome Summary
Attard (2013)	Australia	Pilot Study	1 (case comparison)	Severe chronic Broca's aphasia	CIAT-Plus: intensive therapy	M-MAT	Not clearly specified	SAQOL-39	Showed improvement in communication-related quality of life.
Ciccone (2016)	Australia	Randomized Controlled Trial (RCT)	20 (12 CIAT, 8 Individual)	Acute stroke with aphasia; recruited within 11 days post-onset	CIAT (20 sessions × 45–60 min over 4–5 weeks)	Individual impairment-based aphasia therapy	4–5 weeks (up to 20 sessions)	SAQOL-39	Both groups improved; CIAT slightly better, but not statistically significant.
Pierce (2024)	Australia & NZ	Phase II RCT	70 (sub-study)	Chronic aphasia, >6 mo post-stroke, WAB-R AQ < 93.8	CIAT-Plus: 2 hrs/day, 3 days/week, 5 weeks (30 hrs), group format	M-MAT	5 weeks (30 hrs)	SAQOL-39	No major changes, but QoL scores remained stable over time.
Rose (2022)	Australia	RCT (COMPARE trial)	216 total (70 CIAT-Plus)	Chronic aphasia, >6 mo, community-dwelling	CIAT-Plus: 3 hrs/day, 5 days/week, 2 weeks	M-MAT, usual care	2 weeks	SAQOL-39	Clear improvement in communication-related quality of life.
Kim (2024)	Australia	RCT + Economic Eval	201 (70 CIAT-Plus)	Chronic aphasia, mean age 63 yrs	CIAT-Plus: 3 hrs/day, 5 days/week, 2 weeks (30 hrs), group format	M-MAT and usual care	2 weeks (30 hrs)	EQ-5D, QALY	CIAT-Plus was cost-effective, but did not significantly improve QoL scores.
Richard son (2009)	USA	Single-subject design	6 total (3 dyads)	Mild to severe aphasia, chronic (>3 mo), grouped by severity	CIAT: 2 hrs/day, 10 consecutive weekdays (20 hrs), dyads	Baseline and withdrawal phases	2 weeks	ASHA-QCL	All participants showed moderate to large improvements in QoL scores.
Sharp (2013)	USA	Quasi-experimental comparative study	20 (10 CIAT, 10 Traditional)	Adults with expressive aphasia post-stroke	CIAT: 10 sessions over 2 weeks	Traditional aphasia therapy: 6 sessions over 2 weeks	2 weeks	Quality of Life Scale (QOLS)	CIAT showed significant language gains but not QoL changes.

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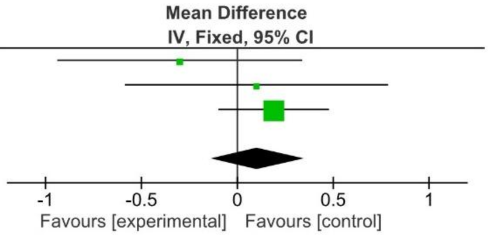
Study or Subgroup	CIAT Mean	CIAT SD	CIAT Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Ciccone 2016	3.6	0.6	8	3.9	0.7	8	14.7%	-0.30 [-0.94, 0.34]
Pierce 2024	3.7	1	10	3.6	0.6	16	12.8%	0.10 [-0.59, 0.79]
Rose 2022	3.08	0.86	70	2.89	0.88	70	72.5%	0.19 [-0.10, 0.48]
Total (95% CI)			**88**			**94**	**100.0%**	**0.11 [-0.14, 0.35]**

Heterogeneity: Chi² = 1.88, df = 2 (P = 0.39); I² = 0%
Test for overall effect: Z = 0.85 (P = 0.40)



SD = standard deviation; IV = inverse-variance; CI = confidence interval.

Figure 2. Forest plot of the SAQol-39 Score (CIAT vs Control)

Methodological Quality

Three RCT trials were appraised using the RoB 2 tool. The risk of bias was low in all domains in one trial[28], while two trials were considered to have some concerns[27,29], primarily concerning the failure of blinding participants or therapists and possible deviations from planned interventions.

Two randomized experimental studies were critically appraised using the JBI Critical Appraisal Checklist. The first, a quasi-experimental design comparison of CIAT with traditional therapy, had high-quality methodology with 8/9 score[32]. The second, an A-B-A single-case experimental design with an A-B-A single-case experimental design, had 7/8 score[30] with good reporting and internal validity but low generalizability due to the very small sample size (n=2).

Finally, a single-case multiple baseline study was also evaluated through the JBI checklist. It was of moderate quality[31], with good procedural and result descriptions but potential problems with variation of baseline and strength of replication.

Meta-Analysis of Effects of Constraint-Induced Aphasia Therapy on SAQoL-39 Scale

In designing and performing the meta-analysis, methodological and clinical heterogeneity across the included studies was minimal. All three studies were randomized controlled trials comparing CIAT with either individual therapy or multimodality aphasia therapy (M-MAT), focusing on quality of life outcomes measured using the SAQoL-39 scale. Clinically, the studies varied slightly in treatment intensity and population characteristics, ranging from early to chronic post-stroke phases and differing in sample sizes.

To accommodate these variations, a fixed-effects model was employed to analyze three studies reporting post-intervention SAQoL-39 scores. The meta-analysis demonstrated no significant overall difference in quality of life outcomes between CIAT and control interventions (MD = 0.11, 95% CI = –0.14 to 0.35, Z = 0.85, p = 0.40), indicating comparable efficacy across treatment types. Individual study effect sizes varied. Study by Rose et al[29] showed the largest weight due to its sample size, with a modest positive effect favoring CIAT (MD = 0.19, 95% CI = –0.10 to 0.48). Pierce et al. (2024)[28] demonstrated a near-neutral effect (MD = 0.10, 95% CI = –0.59 to 0.79), while Ciccone et al. (2016)[27] showed a small, non-significant effect favoring control (MD = –0.30, 95% CI = –0.94 to 0.34). The meta-analysis showed no heterogeneity between studies (I^2 = 0%, χ^2 = 1.88, p = 0.39), indicating consistency in the direction and magnitude of effects despite differences in study design and populations. This strengthens the conclusion that CIAT has a quality of life outcome profile comparable to other standard aphasia therapies.

The vertical dashed line indicates the pooled effect size derived from the meta-analysis, while the diagonal lines represent the expected 95% confidence interval boundaries around this estimate. Each circle represents an individual study.

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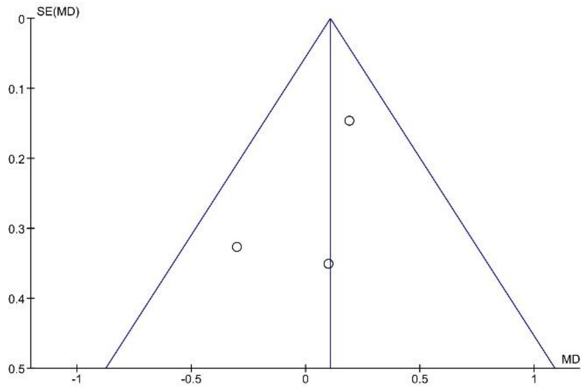

Figure 3. Funnel plot of the effect size according to standard errors

DISCUSSION

Implications from our review suggest that CIAT can improve QoL in individuals with post-stroke aphasia. Additionally, results from our meta-analysis attest to the beneficial effect of CIAT on QoL outcomes, particularly in terms of communication-related outcomes, though the overall mean difference was not significant. For all that lacking significant group-level impact, the direction of the effect was consistent across the majority of the studies reviewed, and the impact was in favor of CIAT.

Subsequent aphasia rehabilitation literature has emphasized that language gain in itself may not fully capture patient-relevant outcomes unless functional communication and psychosocial engagement are also taken into account[33-35]. The majority of studies employed the SAQOL-39, specifically designed to quantify QoL in people with aphasia, and intervention protocols, while varying in length and intensity, tended to be associated with CIAT and enhanced patient-reported QoL scores.

Significantly, trials that incorporated multimodal or personalized components to CIAT, such as COMPARE trial[28,29], showed enhanced communication factors in the SAQOL-39. It aligns with the statement that QoL in aphasia is not only a matter of proper usage of language but also functional use and confidence during daily circumstances[36]. In contrast, Sharp[32] and Ciccone et al[27] found no differences in QoL scores post-intervention, yet there was language outcome improvement, which suggests that therapeutic outcomes do not always automatically translate to perceived life quality unless contextual and social participation facets are being targeted.

Delivery variability of intervention, e.g., session frequency, group or individual session, and therapists' training, was also noted through our analysis. This heterogeneity would have created variation in outcome and highlights the requirement for standard but flexible treatment systems. Finally, the inclusion of non-randomized and small-N studies[30-32] highlights both potential and methodological restrictions within current CIAT research. Even while these studies reported significant QoL and naming improvement, restricted generalizability and high risk of performance or measurement bias require cautionary interpretation.

In measuring outcomes, there was heterogeneity in the time of assessment between trials, where some measured QoL at immediate post-treatment and others with more prolonged follow-up. This introduces uncertainty in interpreting whether CIAT's outcomes are temporary or long lasting in nature. Given that QoL is a dynamic and dependent factor for environmental, emotional, and social variables, future research should incorporate longitudinal designs to measure the temporal effect of CIAT.

While overall findings are encouraging, our review did identify areas of high-priority gaps. Firstly, few trials included non-language control groups (e.g., attention or social interaction without therapy structure), and this meant it was difficult to distinguish the linguistic benefits of CIAT from non-specific psychosocial engagement. Secondly, even where individual trials had robust findings, the lack of significant effects at the aggregated level suggests a need that is unmet for larger, multi-site RCTs to ascertain efficacy in a variety of populations.

From a clinical perspective, the evidence is in favor of using CIAT as an effective language therapy with functional relevance to patients' lives. Its intensity, group-oriented, and socially embedded methodology make it singularly well-placed to address both linguistic damage and QoL concerns in aphasia rehabilitation. CIAT may therefore be part of wide-ranging recovery models prioritizing not only language recovery but also returning patients to communicative life.

Overall, this review supports the application of CIAT as a systematic and reachable intervention with

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the capability to enhance communication-related quality of life in individuals with aphasia. Future research needs to concentrate on standardizing intervention protocols, examining transfer mechanisms into daily life, and examining long term impacts of CIAT on communication and psychosocial well-being. Ideally, the integration of CIAT into patient-centered neurorehabilitation could boost both functional recovery and personal perception of quality of life following stroke.

ETHICAL APPROVAL

This study is a systematic review and meta-analysis that did not involve direct human subject involvement or use of individual patient data. Therefore, ethical approval was not needed.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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AUTHOR CONTRIBUTIONS

All of the authors equally contributed to the study

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