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Surface Electromyographic Biofeedback Therapy Can Improve Electrophysiological Outcomes in Post-Stroke Dysphagia: A Systematic Review and Network Meta-Analysis

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ADMINISTRATIVE INFORMATION

Support - No.

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 13 May 2025 and was last updated on 13 May 2025.

INTRODUCTION

Review question / Objective This study aims to systematically evaluate and conduct a network meta-analysis to investigate the efficacy of sEMG-BF in improving electrophysiological outcomes in post-stroke dysphagia, thereby providing high-quality evidence for clinical practice.

Condition being studied Post-stroke dysphagia is a common complication with a high incidence rate, significantly impairing patients' quality of life and health status. Although traditional swallowing training is widely used, its efficacy exhibits considerable individual heterogeneity. Surface electromyographic biofeedback (sEMG-BF), as an emerging rehabilitation technology, shows promising potential. However, there is a lack of systematic and comprehensive evaluation as well as high-quality evidence to support its clinical application.

METHODS

Participant or population This investigation utilized a dual methodological approach combining systematic evidence synthesis with advanced network meta-analytical techniques to rigorously assess the therapeutic effectiveness of sEMG-BF for managing swallowing disorders following cerebrovascular accidents, aiming to provide high-quality evidence for clinical decision-making.

Intervention A comprehensive literature search was conducted across five major databases: Scopus, EMBASE, Web of Science, Cochrane CENTRAL, and PubMed/MEDLINE. The search encompassed all available records from each database's inception through April 1, 2025, with language restrictions limited to English and Chinese. Search terms included "surface electromyography biofeedback," "post-stroke dysphagia," and related variations. Tailored search strategies were developed for each database to ensure comprehensiveness and accuracy.

For instance, the PubMed search strategy is as follows:
("stroke" OR "cerebrovascular accident" OR "CVA" OR "brain attack") AND ("dysphagia" OR "swallowing disorder" OR "swallowing difficulty" OR "feeding difficulty") AND ("surface electromyography" OR "sEMG" OR "electromyography" OR "bioelectrical activity")
2.3 Inclusion and Exclusion Criteria
The PICOS (Population, Intervention, Comparison, Outcomes, Study Design) framework was applied to determine eligible studies, as outlined in Table 1.
Table 1. PICOS Criteria for Study Inclusion
Exclusion Criteria
Studies were excluded based on the following criteria: (1) non-randomized studies, including case reports and conference abstracts; (2) studies involving patients with comorbid neurodegenerative disorders (e.g., Parkinson's disease) or head/neck tumors; (3) interventions incorporating invasive biofeedback techniques such as intraluminal manometry; (4) duplicate publications, studies with incomplete data, or those for which full texts were inaccessible; (5) studies with insufficient sample sizes to permit meaningful statistical analysis.

Comparator A comprehensive literature search was conducted across five major databases: Scopus, EMBASE, Web of Science, Cochrane CENTRAL, and PubMed/MEDLINE. The search encompassed all available records from each database's inception through April 1, 2025, with language restrictions limited to English and Chinese. Search terms included "surface electromyography biofeedback," "post-stroke dysphagia," and related variations. Tailored search strategies were developed for each database to ensure comprehensiveness and accuracy.

Study designs to be included Randomized controlled trial.

Eligibility criteria The PICOS (Population, Intervention, Comparison, Outcomes, Study Design) framework was applied to determine eligible studies, as outlined.
Exclusion Criteria
Studies were excluded based on the following criteria: (1) non-randomized studies, including case reports and conference abstracts; (2) studies involving patients with comorbid neurodegenerative disorders (e.g., Parkinson's disease) or head/neck tumors; (3) interventions incorporating invasive biofeedback techniques such as intraluminal manometry; (4) duplicate publications, studies with incomplete data, or those for which full texts were inaccessible; (5) studies with insufficient sample sizes to permit meaningful statistical analysis.
Literature Screening and Data Extraction
The study selection process was performed independently by two investigators using a dual-phase screening approach. In the primary phase, all retrieved citations underwent title and abstract review to identify potentially relevant publications, followed by comprehensive full-text assessment of selected articles in the secondary phase. Inter-rater disagreements were addressed through consensus discussions or arbitration by a senior researcher when required. A customized data collection template was implemented to capture key study elements, including: publication metadata (author names, publication year, country of origin, research design); population characteristics (sample size, demographic parameters, stroke classification); intervention specifications (treatment frequency, duration, biofeedback parameters, adjunct therapies); comparator details (sham procedures, standard care protocols); efficacy metrics (primary and secondary outcomes with corresponding assessment instruments); and temporal evaluation points (post-treatment follow-up intervals). This systematic approach ensured consistent and thorough data acquisition while minimizing selection bias. All extracted data were cross-verified by both researchers to ensure accuracy and completeness prior to analysis.

Information sources A comprehensive literature search was conducted across five major databases: Scopus, EMBASE, Web of Science, Cochrane CENTRAL, and PubMed/MEDLINE. The search encompassed all available records from each database's inception through April 1, 2025, with language restrictions limited to English and Chinese. Search terms included "surface electromyography biofeedback," "post-stroke dysphagia," and related variations. Tailored search strategies were developed for each database to ensure comprehensiveness and accuracy.

Main outcome(s) Six studies were ultimately included in the analysis. sEMG-BF significantly increased mean amplitude (MD = 6.45, 95% CI: 3.53, 9.38) and reduced swallowing duration (MD = -0.22, 95% CI: -0.26, -0.18). Network meta-analysis revealed the following SUCRA ranking: sEMG-BF, neuromuscular electrical stimulation (NMES), and conventional therapy. sEMG-BF also significantly improved the SSA score (MD = -6.43, 95% CI: -9.74, -3.11) and Swallowing QOL score (MD = 29.36, 95% CI: -14.96, 73.69). The network meta-analysis demonstrated that sEMG-BF outperformed NMES and conventional therapy in

improving swallowing function, consistent with direct comparison results.

Quality assessment / Risk of bias analysis The methodological quality of the included randomized controlled trials was rigorously assessed using the Cochrane Collaboration's revised Risk of Bias tool (ROB 2.0), which systematically evaluates potential biases across five critical domains. The tool examined the adequacy of random sequence generation and allocation concealment in the randomization process, potential biases introduced by deviations from protocol including non-adherence or unintended unblinding, handling of missing data with particular attention to dropout rates and adherence to intention-to-treat analysis, objectivity in outcome measurement through assessor blinding and instrument validity, and consistency between pre-specified and reported outcomes to detect selective reporting. Each trial received domain-specific judgments of "low risk," "some concerns," or "high risk" of bias, with these evaluations subsequently synthesized and presented through both summary tables and visual plots for comprehensive interpretation. This systematic approach enabled transparent evaluation of study quality while identifying potential limitations in the evidence base.

Strategy of data synthesis The synthesis comprised two components: traditional pairwise meta-analysis and network meta-analysis (NMA).
Traditional Meta-Analysis
For continuous outcomes (e.g., motor function scores), mean differences (MDs) with 95% confidence intervals (CIs) were calculated using sample sizes, means, and standard deviations. When studies reported medians and interquartile ranges, these values were converted to means and SDs via the method described by Wan et al. (2014) [15], with explicit notation of this transformation in the results. Heterogeneity was quantified via the I^2 statistic and Cochran's Q test; a random-effects model was employed if I^2 exceeded 50%. Subgroup analyses explored potential sources of heterogeneity (e.g., stroke phase, intervention dosage).
Network Meta-Analysis
A frequentist framework was adopted using STATA 17.0's network package(StataCorp, College Station, TX, USA). The geometry of the intervention network was visualized with nodes (treatments) sized by sample volume and edges (direct comparisons) weighted by study count. Consistency between direct and indirect evidence was tested via node-splitting ($P > 0.10$ indicating agreement). Treatment rankings were derived from surface under the cumulative ranking curve (SUCRA) values, where higher percentages denoted superior efficacy.

Subgroup analysis When studies reported medians and interquartile ranges, these values were converted to means and SDs via the method described by Wan et al. (2014) [15], with explicit notation of this transformation in the results. Heterogeneity was quantified via the I^2 statistic and Cochran's Q test; a random-effects model was employed if I^2 exceeded 50%. Subgroup analyses explored potential sources of heterogeneity (e.g., stroke phase, intervention dosage).

Sensitivity analysis When studies reported medians and interquartile ranges, these values were converted to means and SDs via the method described by Wan et al. (2014) [15], with explicit notation of this transformation in the results. Heterogeneity was quantified via the I^2 statistic and Cochran's Q test; a random-effects model was employed if I^2 exceeded 50%. Subgroup analyses explored potential sources of heterogeneity (e.g., stroke phase, intervention dosage).

Country(ies) involved China.

Keywords surface electromyographic biofeedback; stroke; dysphagia; network meta-analysis.

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