Efficacy of electromyographic biofeedback compared with conventional physical therapy for upper-extremity function in patients following stroke: a research overview and meta-analysis

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Authors’ objectives
To examine the efficacy of electromyographic (EMG) biofeedback compared to conventional physical therapy, for improving upper-extremity function in patients following a stroke.

Searching
MEDLINE was searched with the keywords 'electromyography', 'biofeedback' and 'cerebrovascular disorders'; CINAHL with the keywords 'biofeedback' and 'cerebrovascular accident'; and Dissertation Abstracts International with the keywords 'electromyography' and 'biofeedback'. Excerpta Medica was searched manually with a reference follow-up in SciSearch, and authors of relevant articles were contacted for unpublished studies. Searches were performed from 1976 to 1992 and were limited to publications in the English language.

Study selection
Study designs of evaluations included in the review Randomised controlled trials (RCTs) with blinded outcome assessment. Treatment group should contain patients having EMG biofeedback alone or with conventional physical therapy, and control group undergoing conventional physical therapy (excluding feedback devices or functional electrical stimulation).

Specific interventions included in the review
EMG biofeedback and conventional physical therapy.

Participants included in the review
Post-stroke adult patients.

Outcomes assessed in the review
Any functional measure of the upper extremity, including upper-extremity function testing, stage of motor recovery, range of motion and muscle strength. Functional outcomes related to movement as opposed to physiological variables.

How were decisions on the relevance of primary studies made?
Decisions of relevance were assessed independently by the two reviewers, using the weighted Kappa statistic to determine inter-observer reliability. Any disagreements were resolved by consensus.

Assessment of study quality
The studies were assessed on 9 methodological criteria: (1) follow-up of 95% (excluding deaths); (2) treatment and control group comparability (within 10% of age, time post-stroke, receptive communication, sensation, and baseline measures of outcomes variables); (3) provision of equal time and attention to both groups; (4) random allocation of therapists to patients; (5) monitoring of treatment protocols to prevent bias; (6) provision of placebo biofeedback to the control group; (7) avoidance of contamination and cointervention; (8) use of reliable and valid outcome measures; and (9) analysis of withdrawals in the group to which they were randomly allocated. Two reviewers independently applied criteria, with inter-observer agreement for each criterion determined using the Kappa statistic. Any disagreements were resolved by discussion.

Data extraction
Information on patients and facilities, the interventions, the sample size, numbers of drop-outs and results were
abstracted, and any missing information obtained from the authors. The authors do not state how the data were extracted for the review, or how many of the authors performed the data extraction.

**Methods of synthesis**

How were the studies combined?
The studies were combined using the Mantel-Haenszel common odds ratio (OR) with 95% confidence intervals (CIs) through the Cornfield method. The quality criteria used to assess the validity of the studies do not appear to have been employed in combining the studies.

How were differences between studies investigated?
Homogeneity of the ORs was assessed through the Breslow-Day test, which showed no significant variability. Due to the low power of the test for heterogeneity, sensitivity analyses were also undertaken to test a priori hypotheses, namely: treatment monitoring versus no monitoring; treatment consisting of biofeedback combined with conventional therapy versus biofeedback alone; placebo feedback in the control manoeuvre versus no placebo; and acute (less than 6 months) versus chronic conditions. None were statistically significant.

**Results of the review**

Though 6 studies adhered to the acceptance criteria for the review, only 5 studies contained sufficient data to undertake the meta-analysis. Whilst all 5 studies (135 patients) were used to assess function outcomes, only 3 studies (84 patients) were employed to assess impairment outcomes.

The individual study's ORs for functional outcome measures (e.g. UEFT, Action Research Arm Test and Brunnstrom staging) appear to show a favourable response to the treatment compared to the control, but the pooled OR was not significant at 2.16 (95% CI: 0.82, 5.79, P=0.09). Similarly, impairment outcomes had a non significant common OR of 1.29 (95% CI: 0.43, 3.99, P=0.62). Impairment outcomes included grip strength, elbow flexion force and finger oscillation.

**Authors' conclusions**

Evidence shows that there was no statistically-significant difference between the use of EMG feedback alone or combined with conventional therapy, compared with conventional treatment, in the improvement of upper-extremity function in adults who have had a stroke. It is recommended that therapists consider factors such as cost, ease of application and patient preference when deciding between these two forms of treatment.

**CRD commentary**
The authors have undertaken a good-quality review of the efficacy of EMG biofeedback, compared with conventional physical therapy, for upper-extremity function in patients following stroke. The objectives, participants, outcomes, literature search strategy, inclusion and quality criteria and their application, results and conclusions are all clearly stated. Minor criticisms would include no information on the process for data extraction and a lack of data on patient characteristics, settings, and patient drop-outs.

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