Electromyographic biofeedback to improve lower extremity function after stroke: a meta-analysis
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Authors' objectives
To examine the efficacy of electromyographic (EMG) biofeedback, compared with conventional physiotherapy, for improving lower extremity function in stroke patients.

Searching
The authors used a previous strategy (see Other Publications of Related Interest) to search for studies published in the English language between 1976 and 1994. MEDLINE was searched using the keywords 'electromyography', 'biofeedback' and 'cerebrovascular disorders'; CINAHL was searched using the keywords 'biofeedback' and 'cerebrovascular accident'; and Excerpta Medica was scanned manually. For the current review, the authors updated the search to include 1995 and excluded the previous search data from Dissertation Abstracts International, which was not useful. The authors also contacted the authors of the primary studies for any additional published or unpublished studies in English.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs) where the treatment group received EMG biofeedback alone or conventional physical therapy, and the control group received conventional physical therapy excluding alternate feedback devices and functional electrical stimulation.

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

Participants included in the review
Post-stroke adult patients treated in either an in- or out-patient setting.

Outcomes assessed in the review
Functional measures of the lower extremity were assessed. Ankle muscle strength and ankle range of motion were calculated by the difference in the mean change score of the treatment and control groups, divided by the pooled standard deviation of the change scores. Gait quality, ankle length during gait, stride length and gait speed were calculated by the difference in the mean change score of the treatment and control groups, divided by the pooled standard deviation of the post-test scores.

How were decisions on the relevance of primary studies made?
Two authors independently assessed the relevant studies. Inter-observer agreement on whether each study met the selection criteria was calculated using the weighted Kappa-statistic. The reviewers were not blinded to the authors, institutions or results, when selecting the primary studies.

Assessment of study quality
The primary studies were assessed using eight quality indicators.

1. At least 95% follow-up of participants, excluding deaths.

2. Comparability of the treatment and control groups in terms of age, time post-stroke, receptive communication, sensation, and baseline measures of outcome variables.

3. Provision of equal time and attention to both groups.
4. Random allocation of therapists to participants.

5. Monitoring of treatment protocols for accuracy and consistency.

6. Provision of placebo biofeedback to the control group.

7. Avoidance of contamination and cointervention.

8. Analysis of withdrawals in the group to which they were randomised. Two of the authors applied the criteria independently and inter-observer agreement was calculated using the Kappa-statistic. Any disagreements were resolved by discussion.

**Data extraction**
The data were extracted by two investigators. For crossover trials, data were taken only from the first period.

**Methods of synthesis**

*How were the studies combined?*

A meta-analysis was performed where outcomes were analysed in more than one study. The combined effect sizes were calculated using a random-effects model, along with 95% confidence intervals (CIs) and significance levels (Z-test).

Where meta-analyses were not significant (i.e. gait quality, ankle range of motion, ankle angle during gait, and stride length), power analyses were calculated for three estimates of clinically important differences (as selected by one of the authors).

*How were differences between studies investigated?*

Homogeneity of the effect sizes (Q) was tested for using the Q statistic. Where heterogeneity was found, additional sensitivity tests were planned based on the a priori hypotheses that differences between the studies were caused by the following: blinding versus non-blinding; whether there was inclusion of conventional therapy in the treatment group; whether a placebo was given to the control group; or whether treatment monitoring was used.

**Results of the review**

Twelve studies met the inclusion criteria but only eight (112 participants) contained sufficient outcome data for this review.

Inter-observer agreement for study selection was 0.67 on a scale from 0 to 1. The combined effect size for ankle dorsiflexion muscle strength was 1.17 (95% CI: 0.50, 1.85, p=0.0006), which represented a difference of 2.5 kg muscle force in favour of biofeedback.

The combined effect size for gait quality was 0.48 (95% CI: -0.06, +1.01, p=0.08), which represented approximately 0.5 of a point on the Basmajian gait scale in favour of biofeedback.

The combined effect size for ankle range of motion was 0.07 (95% CI: -0.42, +0.57, p=0.78), which represented a difference of 0.7 degrees between biofeedback treatment and control treatment; this difference was not statistically significant.

The combined effect size for ankle angle during gait was 0.51 (95% CI: -0.17, +1.21, p=0.14), which represented a difference of 5.7 degrees in favour of biofeedback.

The combined effect size for stride length was 0.09 (95% CI: -0.56, +0.73, p=0.80), which represented 2.0 cm in favour of biofeedback; this difference was not statistically significant.

The combined effect size for gait speed was 0.31 (95% CI: -0.16, +0.78, p=0.20), which represented a difference of 8.4 m over 2 minutes in favour of biofeedback.
Authors' conclusions
The results indicated that EMG biofeedback was superior to conventional therapy alone for improving ankle dorsiflexion muscle strength.

CRD commentary
The authors addressed the issues of bias by searching for unpublished trials, although non-English trials were excluded.

The inclusion criteria for the individual trials and their participants were stated, as were the criteria for including and assessing the quality of the primary trials. Information was lacking on the data extraction process. The authors pooled the effect sizes and calculated CIs. They also made appropriate tests for heterogeneity and planned additional sensitivity analyses.

The authors conducted power analyses and determined that larger sample sizes were needed.

The results of the review should be viewed with caution because of the interpretation of effect sizes, which can be especially difficult and can be misleading. The authors have also selected an unusual method of randomisation: randomising the therapist to intervention and control, rather than randomising the patients to intervention and control.

Implications of the review for practice and research
Practice: There were no implications for practice.
Research: The authors state that further research on EMG biofeedback for lower extremity training after stroke is required; this should use rigorous methodology and adequate sample sizes.

Bibliographic details

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Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.