Journal of Physiotherapy xxx (2018) xxx–xxx

Journal of PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

Research

Interventions involving repetitive practice improve strength after stroke: a systematic review

Davide G de Sousa [a,b,c], Lisa A Harvey [b,c], Simone Dorsch [d], Joanne V Glinsky [b,c]

[a] Graythwaite Rehabilitation Centre, Ryde Hospital; [b] John Walsh Centre for Rehabilitation Research, Kolling Institute; [c] Sydney Medical School Northern, University of Sydney; [d] Faculty of Health Sciences, Australian Catholic University, Sydney, Australia

KEY WORDS

Stroke
Strength
Repetitive practice
Systematic review
Meta-analysis

ABSTRACT

Questions: Do interventions involving repetitive practice improve strength after stroke? Are any improvements in strength accompanied by improvements in activity? **Design**: Systematic review of randomised trials with meta-analysis. **Participants**: Adults who have had a stroke. **Intervention**: Any intervention involving repetitive practice compared with no intervention or a sham intervention. **Outcome measures**: The primary outcome was voluntary strength in muscles trained as part of the intervention. The secondary outcomes were measures of lower limb and upper limb activity. **Results**: Fifty-two studies were included. The overall SMD of repetitive practice on strength was examined by pooling post-intervention scores from 46 studies involving 1928 participants. The SMD of repetitive practice on strength when the upper and lower limb studies were combined was 0.25 (95% CI 0.16 to 0.34, I^2 = 44%) in favour of repetitive practice. Twenty-four studies with a total of 912 participants investigated the effects of repetitive practice on upper limb activity after stroke. The SMD was 0.15 (95% CI 0.02 to 0.29, I^2 = 50%) in favour of repetitive practice on upper limb activity. Twenty studies with a total of 952 participants investigated the effects of repetitive practice on lower limb activity after stroke. The SMD was 0.25 (95% CI 0.12 to 0.38, I^2 = 36%) in favour of repetitive practice on lower limb activity. **Conclusion**: Interventions involving repetitive practice improve strength after stroke, and these improvements are accompanied by improvements in activity. **Review registration**: PROSPERO CRD42017068658. **[de Sousa DG, Harvey LA, Dorsch S, Glinsky JV (2018) Interventions involving repetitive practice improve strength after stroke: a systematic review. *Journal of Physiotherapy* XX: XX–XX]**

Introduction

The loss of strength after stroke is a common and important impairment. The average strength of the affected upper and lower limb in people who have had a significant stroke ranges from 30 to 50% of age-matched controls.[1–4] This loss of strength can result in profound activity limitations[5–7] and participation restrictions.[8] Therefore, it is important to know which interventions are effective for improving strength after stroke. Progressive resistance training is commonly used to improve strength in people without disability[9] and can be used to improve strength in people after stroke.[10] Progressive resistance training is characterised by muscles working at high loads with low repetitions, that is, a load of 8 to 12 repetitions maximum (RM) for at least two sets with a progressive increase in the load.[9] However, progressive resistance training is not commonly used after stroke, and often when strengthening programs claim to be using progressive resistance training they are not adhering to the guidelines.[11] This may be because progressive resistance training is time-consuming to set up and difficult to implement in people with very weak muscles. In contrast, repetitive practice of tasks can be set up with minimal equipment and modified so that even people with very weak muscles can do some form of training.

Repetitive practice of tasks, such as walking, reaching and manipulation of objects, is a major component of rehabilitation after stroke. Some interventions used to promote repetitive practice include constraint-induced movement therapy, treadmill walking with body-weight support, or robotic devices. These interventions are typically performed with an emphasis on high repetitions and no added resistance to movement; hence, the principles of repetitive practice are very different to the principles of progressive resistance training. Repetitive practice is known to be effective for reducing activity limitations, with many systematic reviews confirming this.[12–15] However, less is known about the effects of repetitive practice on strength after stroke, and no systematic reviews have specifically investigated this issue. Eight systematic reviews with meta-analyses have investigated the effects of strengthening interventions on strength after stroke. These reviews included studies that used progressive resistance training[10,16–20] or an artificial drive of muscle contraction[21,22] (ie, electrical stimulation without attempts to move a limb) as an intervention and did not focus specifically on repetitive practice.

https://doi.org/10.1016/j.jphys.2018.08.004

Since repetitive practice is widely used and recommended in rehabilitation after stroke,[23] it is important to understand if interventions involving repetitive practice are effective for improving strength.

Therefore, the research questions for this systematic review were:

1. Do interventions involving repetitive practice improve strength after stroke?
2. Are any improvements in strength accompanied by improvements in activity?

Method

Identification and selection of studies

Participants

Studies involving adult participants of either gender at any time after stroke were included. Studies that also involved participants with other types of acquired brain injury (eg, trauma) were excluded unless > 80% of participants had a diagnosis of stroke.

Intervention

Studies that examined the effectiveness of interventions that involved repetitive practice on land or in water (ie, hydrotherapy or aquatic physiotherapy) were included. Repetitive practice was defined as repetitive voluntary contraction of muscles of the affected upper or lower limb and included repetitive practice of a whole task (eg, sitting, standing up, walking) or components of a task (eg, elbow extension/flexion as a component of reaching and manipulation). Where constraint-induced movement therapy was used, studies that merely constrained the unaffected upper limb without active practice using the affected upper limb were excluded. Studies were excluded if: the intervention only included an artificial drive of muscle contraction (eg, passive robotics or electrical stimulation without attempts to move a limb), the intervention did not require voluntary muscle contraction (eg, mental practice, massage, passive movement), or the intervention involved progressive resistance strength training (ie, 1 to 3 sets, 8 to 12 repetitions of 60 to 70% 1RM with progression of resistance).

Comparison

The comparisons of interest were no intervention or a sham intervention. Studies with co-interventions were included provided the co-intervention was delivered to both groups (eg, repetitive practice plus usual therapy versus usual therapy).

Outcome measures

The primary outcome for this systematic review was strength. Studies were included if one of their outcomes was strength of the affected upper or lower limb in muscles that were trained. Strength could be measured in a number of ways, including: maximum force, maximum torque, manual muscle testing using the Medical Research Council (MRC) scale, or composite scales of multiple muscle groups such as the Motricity Index. Where multiple measures of strength were reported, the measure that best reflected the training was used. For example, if upper limb training primarily involved manipulation tasks, then hand grip strength was chosen rather than elbow extension strength. If studies reported outcomes at multiple time-points, then data collected at the time-point closest to the end of the intervention were extracted.

The secondary outcomes for this systematic review were activity of the affected upper and lower limb, measured using any continuous or ordinal measure of activity. These secondary outcomes were only collected from studies that met the inclusion criteria for the review. That is, studies that measured activity were only included if they also measured strength, because the analysis of activity was a secondary analysis used to determine whether improvements in strength were accompanied by improvements in activity. Where multiple measures of activity were reported, the measure that best reflected the training was used. For example, if the repetitive practice targeted the lower limb, a lower limb measure such as the 10-m walk test was used rather than a measure of upper limb activity. Priority for the upper and lower limb measures of activity were given to the Action Research Arm Test and the 10-m walk test, respectively, because these outcome measures have been recommended for use in clinical studies by the international research community.[24]

Box 1. Inclusion criteria.

Design
- Randomised

Participants
- Adults (> 18 years old)
- Diagnosis of stroke

Intervention
- Repetitive practice

Comparisons
- Repetitive practice versus no intervention
- Repetitive practice versus a sham intervention

Outcome measures
- Muscle strength measured as maximum force/torque, or composite scales of multiple muscle groups, or manual muscle testing, measured immediately after the intervention in the muscles that were trained

Searches were conducted of MEDLINE (Ovid) (1946 to 24 January 2017), EMBASE (Ovid) (1947 to 24 January 2017), AMED (1985 to 24 January 2017), CINAHL (Ebsco) (1982 to 24 January 2017), SCOPUS (inception to 24 January 2017), SPORTDiscus (Ebsco) (inception to 24 January 2017), Web of Science (inception to 24 January 2017), Cochrane Central Register of Controlled Trials (CENTRAL) (1986 to 24 January 2017) and PEDro (inception to 13 February 2017) for relevant studies written in English with no date restrictions. Search terms included words related to stroke, randomised trials, repetitive practice and muscle strength (see Appendix 1 on the eAddenda). Hand searching of the reference lists of the included studies and relevant systematic reviews was undertaken. Authors of conference abstracts were contacted for full reports of unpublished studies. One reviewer independently screened all titles and abstracts to identify relevant studies. All titles and abstracts were also equally divided and independently screened by three other reviewers, ensuring that all titles and abstracts were screened by two people. Full-text copies of relevant studies were retrieved and reviewed independently by each reviewer using predetermined eligibility criteria (Box 1). If two reviewers disagreed about the eligibility of a study, a third reviewer arbitrated until a consensus was reached.

Assessment of risk of bias

One reviewer independently assessed risk of bias of the included studies using the Cochrane Risk of Bias Tool. Each study was rated as high risk, unclear risk or low risk on the following domains: sequence generation; concealed allocation; blinding of participants and therapists; blinding of outcome assessors; incomplete outcome data; selective outcome reporting; and other bias. Studies were checked online against published PEDro scores to assist with decisions regarding bias, and disagreements were resolved by a second reviewer. Studies that reported incomplete data in more than 15% of participants were deemed to have high risk of bias from incomplete outcome data. Studies that did not report a clinical trial registration number or registered the protocol retrospectively were deemed to have unclear risk of bias in the category of 'other bias'.

Please cite this article in press as: de Sousa DG, et al. Interventions involving repetitive practice improve strength after stroke: a systematic review. *J Physiother.* (2018), https://doi.org/10.1016/j.jphys.2018.08.004