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Passive movements for the treatment and prevention of contractures (Review)

Prabhu RKR, Swaminathan N, Harvey LA

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[Intervention Review]

Passive movements for the treatment and prevention of contractures

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ABSTRACT

Background

Contractures, a common complication following immobility, lead to restricted joint range of motion. Passive movements (PMs) are widely used for the treatment and prevention of contractures; however, it is not clear whether they are effective.

Objectives

The aim of this review was to determine the effects of PMs on persons with contractures or at risk of developing contractures. Specifically, the aim was to determine whether PMs increase joint mobility.

Search methods

We searched the Cochrane Injuries Group Specialised Register, the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE (Ovid SP), EMBASE (Ovid SP), ISI Web of Science (SCI-EXPANDED; SSCI; CPCI-S; CPCI-SSH), PEDro and PsycINFO (Ovid SP). The search was run on 21 November 2013.

Selection criteria

Randomised controlled trials of PMs administered for the treatment or prevention of contractures were included. Studies were included if they compared the effectiveness of PMs versus no intervention, sham intervention or placebo in people with or at risk of contracture. Studies that involved other co-interventions were included, provided the co-interventions were administered in the same way to all groups. Interventions administered through mechanical devices and interventions that involved sustained stretch were excluded.

Data collection and analysis

Three independent review authors screened studies for inclusion. Two review authors then extracted data and assessed risk of bias. Primary outcomes were joint mobility and occurrence of adverse events such as joint subluxations or dislocations, heterotopic ossification, autonomic dysreflexia and fractures or muscle tears. Secondary outcomes were quality of life, pain, spasticity, activity limitations and participation restrictions. We used standard methodological procedures as advocated by the *Cochrane Handbook for Systematic Reviews of Interventions*.

Main results

Two identified studies randomly assigned a total of 122 participants with neurological conditions comparing PMs versus no PMs. Data from 121 participants were available for analysis. Both studies had a low risk of bias. One within-participant study involving 20 participants (40 limbs) measured ankle joint mobility and reported a mean between-group difference of four degrees (95% confidence interval (CI), two to six degrees) favouring the experimental group. Both studies measured spasticity with the Modified Ashworth Scale, but the results were not pooled because of clinical heterogeneity. Neither study reported a clinically or statistically relevant reduction in spasticity with PMs. In

one study, the mean difference on a tallied 48-point Modified Ashworth Scale for the upper limbs was one of 48 points (95% CI minus two to four points), and in the other study, the median difference on a six-point Modified Ashworth Scale for the ankle plantar flexor muscles was zero points (95% CI minus one to zero points). In both studies, a negative between-group difference indicated a reduction in spasticity in the experimental group compared with the control group. One study with a total of 102 participants investigated the short-term effects on pain. The mean difference on a zero to 24-point pain scale was -0.4 points in favour of the control group (95% CI -1.4 to 0.6 points). The GRADE level of evidence about the effects of PMs on joint mobility, spasticity and pain is very low. Neither study examined quality of life, activity limitations or participation restrictions or reported any adverse events.

Authors' conclusions

It is not clear whether PMs are effective for the treatment and prevention of contractures.

PLAIN LANGUAGE SUMMARY

Passive movements for the treatment and prevention of contractures

This Cochrane systematic review determines the effects of passive movements for contractures.

Passive movements are regularly administered for the treatment and prevention of contractures. They are typically administered manually by physiotherapists or care givers. The primary aim of passive movements is to improve joint mobility. The results of this review indicate that it is not yet clear whether passive movements are effective for the treatment and prevention of contractures.

What are contractures?

Contractures are characterised by stiffness around joints that restricts joint mobility. Contractures are common in people with paralysis such as those with stroke, spinal cord injury and cerebral palsy, and they lead to various other complications such as pain, pressure ulcers and deformities.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Short-term effects on spasticity, pain and joint mobility

Short-term effects on spasticity, pain and joint mobility

Patient or population: patients with or at risk of contractures
Settings: nursing home or community
Intervention: PMs versus no PMs

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	PMs versus no PMs				
Spasticity Tallied Modified Ashworth Scale Follow-up: mean 1 day	Data were not pooled	Data were not pooled	Not estimable	121 (two studies)	⊕⊖⊖⊖ **very low**[1,2,3]	
Pain Pain Assessment Checklist for Seniors With Limited Ability to Communicate Scale from: 0 to 24 Follow-up: mean 1 day	Mean pain in control groups was **3.8 points**	Mean pain in intervention groups was **0.4 higher** (0.56 lower to 1.36 higher)	Not estimable	101 (one study)	⊕⊖⊖⊖ **very low**[1,2,3]	
Joint mobility Ankle dorsiflexion range of motion. Scale from 0 to 120 Follow-up: mean 1 day	Mean joint mobility in control groups was **12 degrees**	Mean joint mobility in intervention groups was **4.05 higher** (1.65 to 6.46 higher)	Not estimable	40 (one study)	⊕⊖⊖⊖ **very low**[1,2,3]	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval.

GRADE Working Group grades of evidence.
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1]Consistency had been downgraded by one point because only one trial is included, and therefore the results cannot be consistent across different trials.
[2]Indirectness had been downgraded by one point because only one trial is included, and therefore the results cannot be generalised.
[3]Imprecision has been downgraded by one point because only one trial is included, and therefore the precision of the estimate from this one trial cannot be confirmed.

BACKGROUND

Passive movements (PMs) are widely utilised for the treatment and prevention of contractures in people with a variety of conditions including spinal cord injury (Harvey 2008; Harvey 2009; Somers 2001) and dementia (Fox 2000; Wagner 2010), as well as in those with serious injuries and medical problems associated with unconsciousness (Stockley 2010; Wiles 2010). Passive movements are often provided on an ongoing daily basis to people with chronic disabilities. Passive movements have been part of routine care for people with or at risk of contractures for at least 60 years (Bennett 1946; Treanor 1950). The cost of administering PMs has never been clarified; however, the cost must be notable because of the time involved in administering PMs and the associated salary costs.

Description of the condition

Contractures are characterised by restricted passive range of motion due to limited extensibility or increased stiffness of soft tissues overlying joints such as periarticular structures and muscles (Farmer 2001; Halar 1988). They are a common complication of many neurological and musculoskeletal conditions (Mollinger 1993; Souren 1995; Yarkony 1985) and may result in unsightly deformities. Contractures are also undesirable because they interfere with activities of daily living and are associated with pain, sleep disturbances and pressure ulcers (Fox 2000; Harvey 2002; Mollinger 1993; Scott 1981; Yarkony 1985). For example, contractures of the upper or lower limbs can limit a person's ability to dress, bathe, walk or feed, leading to a life of dependency (Fergusson 2007; Harvey 2001).

Few studies provide unbiased population-based estimates of the incidence and prevalence of contractures (Fergusson 2007). However, evidence from studies of representative samples drawn from tertiary care facilities indicates that 60% of patients surviving physically disabling stroke develop contractures within 12 months (Sackley 2008), 48% of people with spinal cord injuries develop hand contractures over the course of their lives (Harvey 2001a; Krause 2000) and 16% of patients admitted for rehabilitation after head injury develop ankle contractures before discharge (Singer 2004). One large study of more than 1.5 million nursing home residents in the United States showed that 29% of all residents had contractures (Harrington 2006). Two recent cohort studies reported an incidence rate of shoulder contracture in people with spinal cord injury of 30% (Eriks-Hoogland 2009) and of any joint of 66% (Diong 2012). A similar study found that 52% of people with stroke developed at least one major contracture within six months of stroke (Kwah 2012). These data suggest that contractures are particularly prevalent in non-ambulant populations (Harvey 2002).

Description of the intervention

Passive movements are an intervention whereby an individual's joints are cyclically moved through available range of motion by another person, typically a therapist or a care giver (Wiles 2010). The primary goal of PMs is to maintain or increase joint mobility by influencing the extensibility of soft tissues overlying joints. They are also used to decrease secondary complications associated with cartilage degeneration. Typically PMs are administered for a few minutes to joints that people cannot move themselves because of paralysis, pain or limited consciousness. No consensus has been reached about the speed at which PMs should be administered, although PMs are typically applied more slowly to people with spasticity than to those without spasticity. In people with many affected joints, PMs can take 20 to 30 minutes to administer. In some patients with neurological disabilities, PMs are administered every day throughout a person's life (Stockley 2010).

How the intervention might work

It is unclear how PMs work, although most assume that if lack of movement causes contractures, then imposed movement must prevent contractures. Some argue that PMs prevent the formation of adhesions within and about the soft tissues of joints. This may be accomplished by preventing the formation of cross-bridges within collagen (Farmer 2001). Others claim that PMs influence the extensibility of soft tissues (i.e. passive length and stiffness). Passive movements may also influence the excitability of lower motor neurons, reducing spasticity in individuals with neurological disabilities and thereby directly or indirectly increasing muscle extensibility (Farmer 2001; Jamshed 2010; Wiles 2010). However, most of these claims are based on a small body of work in animals (Williams 1984) and are largely unsubstantiated in people.

Why it is important to do this review

Despite the fact that PMs are regularly administered to people with or at risk of developing contractures, it is not clear whether they are effective. Two Cochrane reviews have looked at similar interventions for the treatment and prevention of contractures. One examined continuous passive motion following total knee arthroplasty and provided high-quality evidence that although continuous passive motion increases passive knee flexion (mean difference two degrees, 95% CI zero to five) and active knee flexion (mean difference three degrees, 95% CI zero to six), the effects are too small to be clinically worthwhile (Harvey 2010). The results of this review have raised doubts about the effectiveness of PMs because continuous passive motion provides similar cyclic movement to joints as PMs, although the response of joints to cyclic movement following total knee arthroplasty may be different from the response of joints not affected by trauma (the focus of this review). The other Cochrane review examined the efficacy of stretch and provided high-quality evidence to indicate that stretch administered on a regular basis for less than seven months has no clinically important short-term effects (mean difference one degree, 95% CI zero to three) or long-term effects (mean difference zero degrees, 95% CI minus two to two) on joint range of motion (Katalinic 2010). It is not clear whether PMs differ from stretch. Perhaps cyclic movement provided through the hands of therapists provides a different mechanical stimulus than is provided by stretch.

It is important to ascertain the effectiveness of PMs because contractures are a common problem and are associated with many adverse complications, and because PMs are costly to administer. A better understanding of the therapeutic effects of PMs is an important first step towards progressing the management of contractures.

OBJECTIVES

The aim of this review was to determine the effects of PMs on persons with contractures or at risk of developing contractures. Specifically, the aim was to determine whether PMs increase joint mobility.

METHODS

Criteria for considering studies for this review

Types of studies

The methods used in this review are based on a previously published protocol (Prabhu 2011). Published and unpublished randomised controlled trials were considered for inclusion.

Types of participants

This review included studies involving participants with existing contractures or those at risk of developing contractures (examples of the types of participants considered for inclusion can be found in Appendix 1). Participants of either gender and of any age were included. Participants were included regardless of sensory or motor impairments and were separated according to their broad diagnostic groups. Data were not pooled across diagnostic groups.

We excluded participants who were receiving PMs to joints specifically affected by surgery or trauma (e.g. participants who had undergone recent total knee arthroplasty, participants with hand trauma).

Types of interventions

This review included studies in which PMs were delivered with the aim of treating or preventing contractures. Passive movements are defined as cyclic movements of joints administered manually through the hands of another person (typically a therapist or a care giver). Only synovial joints were included.

Studies that involved other co-interventions (e.g. electrical stimulation) were included, provided the co-interventions were administered in the same manner to both control and experimental group participants.

Interventions administered through mechanical devices such as continuous passive motion machines or leg cycles and interventions that involved sustained stretch were excluded.

Types of comparisons

Studies were included if they compared the effectiveness of PMs versus no intervention, sham intervention or placebo. Comparisons of PMs versus other interventions such as stretching, positioning and splinting were not included. In studies with multiple treatment groups, only data from the two groups with the most contrasting interventions were extracted (e.g. if a study included PM, placebo and control groups, then only data from the PM and placebo groups were extracted).

Types of outcome measures

Primary outcomes

Primary outcomes were:

- joint mobility, including measures of active or passive range of motion with or without standardised torques. Units of measure were expressed in degrees (degree per unit of torque) or centimetre. Unidirectional and bidirectional range of motion measurements were included; and
- adverse events, grouped in the following ways: joint subluxations or dislocations, heterotopic ossification, autonomic dysreflexia (an exaggerated response of the sympathetic nervous system typically seen in people with spinal cord injury), fractures and muscle tears.

Secondary outcomes

Secondary outcomes were:

- quality of life, including measures such as the Short Form-36 (SF-36) (Ware 1992);
- pain, including measures such as a visual analogue scale (Huskisson 1974) or a numerical rating scale (Downie 1978);
- spasticity, including measures such as the Modified Ashworth Scale (Bohannon 1987) or the Tardieu Scale (Tardieu 1954);
- activity limitations, including measures such as the Functional Independence Measure (Keith 1987) or the Barthel Index (Mahoney 1965); and
- participation restrictions, including measures reflecting return to work, leisure or home life.

Timing of outcome measures

Studies were included regardless of when outcomes were measured with respect to the last treatment. However, outcome measures were categorised in the following ways.

- Immediate effects (outcome measures taken less than 24 hours after administration of the last dose of PMs).
- Short-term effects (outcome measures taken between 24 hours and one week after administration of the last dose of PMs).
- Long-term effects (outcome measures taken longer than one week after administration of the last dose of PMs).

If studies collected data at multiple points within one of the predetermined time frames, data collected at the last time were used.

Search methods for identification of studies

No language restriction was applied to any component of the search strategies.

Electronic searches

The Cochrane Injuries Group Trials Search Co-ordinator searched the following databases.

- Cochrane Injuries Group Specialised Register (21 November 2013).
- Cochrane Central Register of Controlled Trials (CENTRAL) (2013, Issue 10 of 12).
- MEDLINE (Ovid SP) (1946 to 20 November 2013).
- EMBASE (Ovid SP) (1974 to 20 November 2013).
- ISI Web of Science: Science Citation Index—Expanded (SCI-EXPANDED) (1970 to November 2013).
- ISI Web of Science: Social Sciences Citation Index (SSCI) (1970 to November 2013).
- ISI Web of Science: Conference Proceedings Citation Index—Science (CPCI-S) (1990 to November 2013).
- ISI Web of Science: Conference Proceedings Citation Index—Social Sciences & Humanities (CPCI-SSH) (1990 to November 2013).

- PEDro (Physiotherapy Evidence Database; http://www.pedro.org.au/; November 2013).
- PsycINFO (1806 to November Week 3 2013).

Search strategies are listed in Appendix 2.

Searching other resources

The reference lists of published and unpublished studies were also searched. Citation tracking of all included studies was used.

Data collection and analysis

Selection of studies

The three review authors independently screened the results of the search for relevant articles based on titles and abstracts. The full texts of studies identified as potentially relevant were retrieved and were again screened by the three review authors for eligibility. No disagreements occurred among review authors.

Data extraction and management

Two review authors (RKRP and NS) independently extracted data from the included studies using a previously used and tested Excel spreadsheet. Differences in the data extracted by the two review authors were resolved by discussion and, when necessary, were arbitrated by the third review author (LAH) or by a fourth person if the difference was related to a paper authored by LAH. The following data were extracted.

- Study design, inclusion and exclusion criteria.
- Characteristics of participants, including type of health condition, number of participants, age and gender, and whether participants were at risk of contractures or had existing contractures, or a combination of the two.
- Characteristics of interventions and comparisons, including details of treatment and control interventions, duration of intervention, frequency of intervention, intensity of intervention, details of co-intervention, compliance with treatment and target joint.
- Details of primary and secondary outcomes, including methods used to measure joint mobility, adverse events, spasticity, time between PMs and outcome measures.
- Dropouts.

Analysis of co-variance (ANCOVA) adjusted between-group means and standard deviations were extracted in preference to change scores. However, if neither were provided, post-intervention scores were used.

Assessment of risk of bias in included studies

The methodological quality of the randomised controlled trials was assessed independently by two review authors (RKRP and NS).

Study quality was assessed by the recommended approach for assessing risk of bias in studies included in Cochrane reviews (Higgins 2011). The following methodological domains were assessed.

- Sequence generation.
  - Low risk of bias: using a computerised random generator, random number tables, coin tossing or any other valid method.
  - High risk of bias: sequence generation and allocation done by invalid methods such as using odd or even date of birth, or allocation by judgement of the clinician.
  - Unclear risk of bias: insufficient information provided about the sequence generation process.
- Allocation sequence concealment.
  - Low risk of bias: allocation concealed so that neither investigators nor participants know group assignment at the time of study entry. Valid methods include central randomisation and serially numbered, opaque, sealed envelopes.
  - High risk of bias: method of allocation is not concealed (e.g. list of random numbers, unsealed or non-opaque envelopes), leading to transparency in group assignments, thereby introducing selection bias.
  - Unclear risk of bias: insufficient information provided about the concealed allocation process.
- Blinding of participants, personnel and outcome assessors.
  - Low risk of bias: either participants or some key study personnel could not be/were not blinded, but outcome assessment was blinded and non-blinding of others is unlikely to introduce bias.
  - High risk of bias: no blinding or incomplete blinding, and outcome measurement is likely to be influenced by lack of blinding.
  - Unclear risk of bias: insufficient information, or study did not mention it.
- Incomplete outcome data.
  - Low risk of bias: missing data have been imputed using appropriate methods such as intention-to-treat analysis.
  - High risk of bias: authors did not impute intention-to-treat analysis for missing data.
  - Unclear risk of bias: insufficient reporting of attrition/exclusions, no reasons for missing data provided.
- Selective outcome reporting.
  - Low risk of bias: published article reports primary and secondary outcomes that are of interest to the review in the prespecified way.
  - High risk of bias: study does not report the prespecified primary outcome.
  - Unclear risk of bias: insufficient information to permit judgement of yes or no.
- Other potential threats to validity.
  - Low risk of bias: study appears to be free of other sources of bias.
  - High risk of bias: bias pertaining to study design is present (e.g. extreme baseline imbalance).
  - Unclear risk of bias: insufficient information to assess whether any important risk of bias exists.

Measures of treatment effect

We planned to pool the mean differences in outcomes for each study to provide a summary estimate of the effectiveness of PMs. For continuous outcomes with the same units, effects were

expressed as mean differences and 95% confidence intervals (CIs). For continuous outcomes with different units, effects were expressed as standardised mean differences and 95% CIs.

Dealing with missing data

We planned to contact study authors if data were missing. However, no data were missing from the two retrieved studies.

Assessment of heterogeneity

We planned to consider meta-analyses for outcomes with data from at least two homogenous studies (studies that investigated the effects of similar interventions on similar populations and reported similar outcomes). In such circumstances, we planned to use the I^2 statistic to quantify the heterogeneity of outcomes and to guide decisions about whether to pool data. When heterogeneity was substantial ($I^2 > 50\%$), we planned to explore possible causes of heterogeneity through sensitivity analyses in which individual studies are omitted one at a time or are stratified by particular characteristics. However, assessment of heterogeneity was not ultimately done because of the small number of retrieved studies.

Assessment of reporting biases

We planned to explore the possibility of small sample bias using funnel plots. However, this was not ultimately done because of the small number of retrieved studies.

Data synthesis

We planned to conduct meta-analyses using a random-effects model to determine pooled risk ratio and mean or standardised mean differences with 95% CIs for dichotomous and continuous outcomes, respectively, using Review Manager 5 (RevMan) (Review Manager). However, studies were insufficient to permit pooling of data within a meta-analysis.

Subgroup analysis and investigation of heterogeneity

We planned to explore the following issues through multiple comparisons but did not because of the small number of retrieved studies.

- Immediate effects of PMs (i.e. effects present less than 24 hours after administration of the last dose of PMs) versus short-term effects of PMs (i.e. effects present between 24 hours and one week after administration of the last dose of PMs) versus long-term effects of PMs (i.e. effects present longer than one week after administration of the last dose of PMs).
- Effects of PMs administered in different dosages.
- Effects of PMs administered to participants with spasticity versus participants without spasticity.

Sensitivity analysis

We planned to use sensitivity analyses to examine the following issues but did not because of the small number of retrieved studies.

- Blinding of assessors: blinding versus no blinding.
- Allocation concealment: concealed versus non-concealed.
- Dropouts: < 15% versus > 15%.

Grading the quality of the evidence

GRADE was used to assess the quality of evidence using GRADEpro software (GRADE Working Group 2004; GRADEpro 2008).

Summary of findings tables

'Summary of findings' tables were compiled using GRADEpro software.

RESULTS

Description of studies

See Characteristics of included studies and Characteristics of excluded studies.

Results of the search

Results of the searches yielded a total of 7998 references, of which 2658 were duplicates (Figure 1). After screening of titles and abstracts, 16 studies were identified as potentially eligible. After the full articles were read, two studies were included and 14 studies were excluded. Reasons for exclusion are summarised in the Characteristics of excluded studies table. No potentially eligible study was excluded on the basis of language.

Figure 1. Study flow diagram.

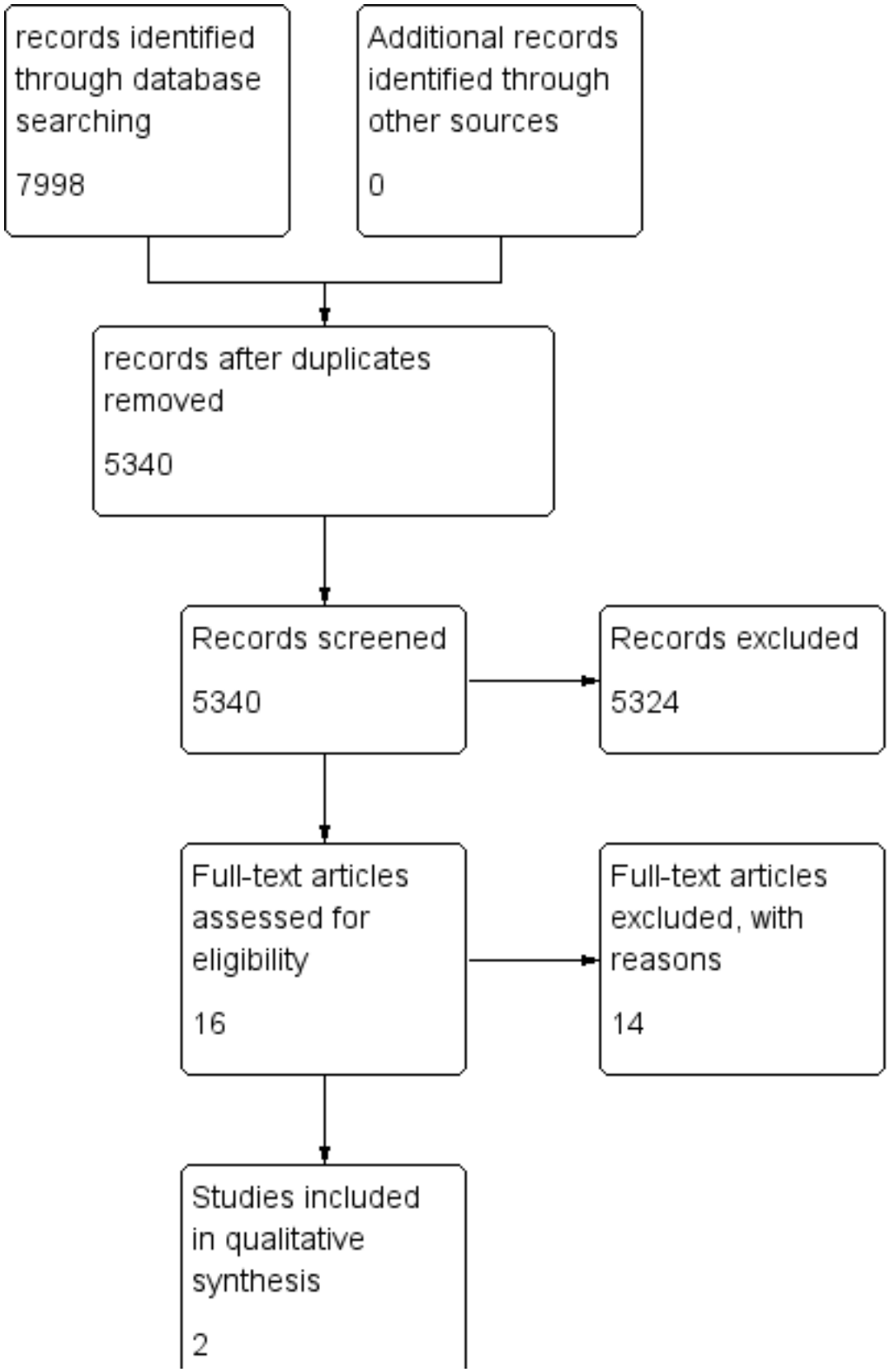
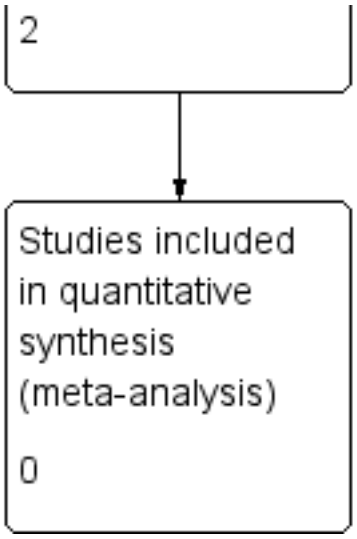


Figure 1. (Continued)



Included studies

Two studies of 122 participants were identified that compared PMs versus no PMs. However, data from only 121 participants were available for analysis. One study used a within-participant design with 20 participants and 40 limbs (Harvey 2009). Both studies investigated the effects of PMs in persons with neurological conditions (Harvey 2009; Hobbelen 2012). One study included people with spinal cord injury, and the other elderly people with paratonia.

In the two studies, PMs were administered with the aim of treating or preventing contractures (Harvey 2009); however, an additional aim of one study was to reduce muscle tone (Hobbelen 2012). Passive movements were administered by participants' care givers in one study (Harvey 2009) and by therapists in the other (Hobbelen 2012). In both studies, PMs were administered for a total of 20 minutes a day, although in one study, PMs were administered only to one joint, and in the other study, they were administered to all joints of the upper and lower limbs. In one study, PMs were administered five times a week for six months (Harvey 2009), and in the other study, they were administered three times a week for four weeks (Hobbelen 2012).

The only three outcomes of interest reported were joint mobility (Harvey 2009), pain (Hobbelen 2012) and spasticity (Harvey 2009; Hobbelen 2012).

Participants were assessed one day after six-month (Harvey 2009) and four-week (Hobbelen 2012) intervention periods. Thus, both studies assessed only short-term effects of PMs.

Further characteristics of the included studies are detailed in the Characteristics of included studies tables.

Excluded studies

See Characteristics of excluded studies.

Risk of bias in included studies

Both studies have a low risk of bias (Figure 2 and Figure 3).

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies. Two studies are included in this review.

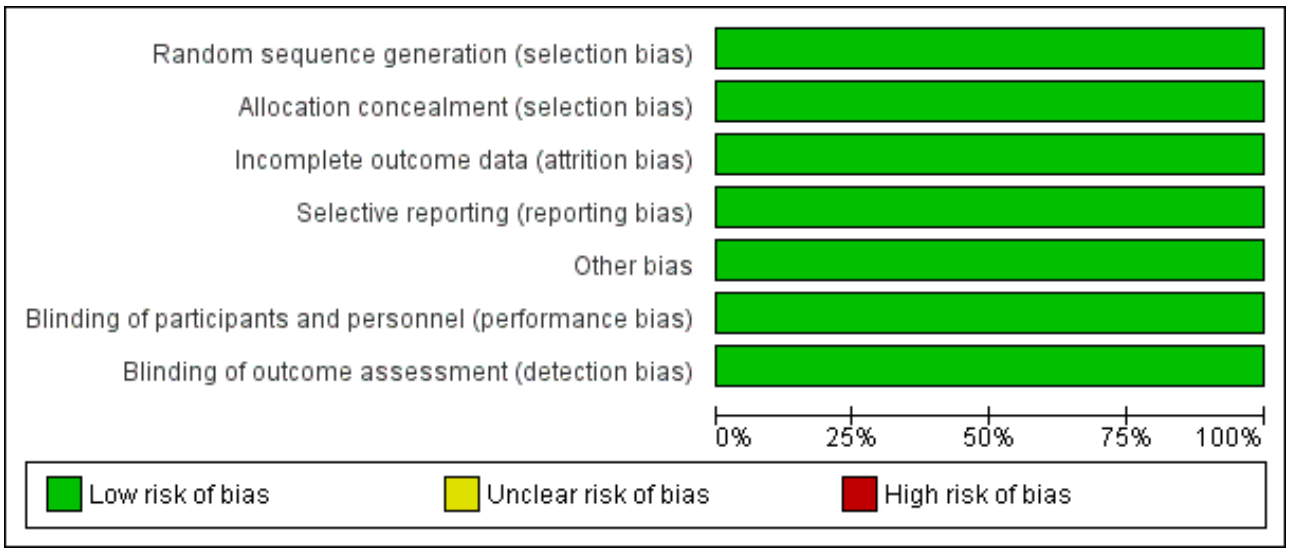
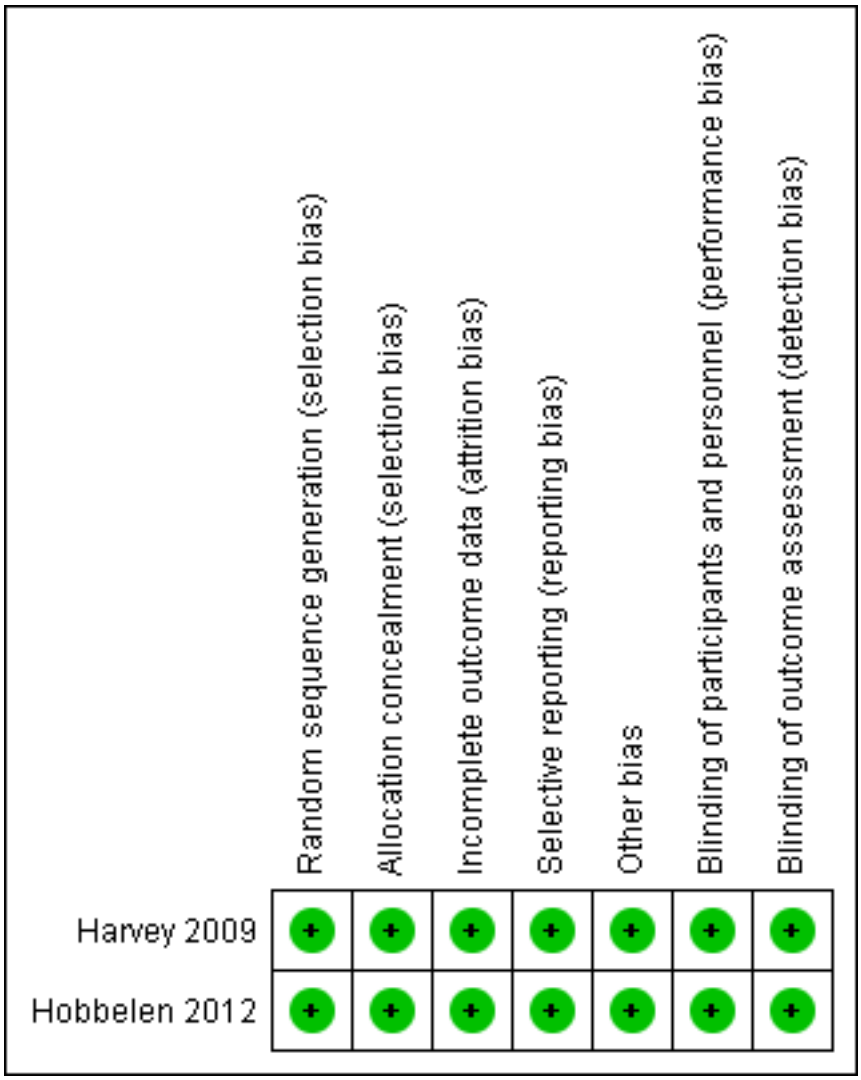


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

Both of the included studies used adequate methods of generating the randomisation sequence and concealed allocation (see Characteristics of included studies).

Blinding

Blinding of participants and therapists was not possible in either of the studies because of the nature of the intervention. Both studies reported blinding of outcome assessors.

Incomplete outcome data

Both studies had adequate follow-up.

Selective reporting

No evidence of selective reporting was found. This was checked in one trial (Hobbelen 2012) through its published protocol (Hobbelen 2007) and in the other trial (Harvey 2009) through examination of details provided through the Australian New Zealand Clinical Trials Registry (ACTRN12607000220460).

Other potential sources of bias

The studies were free of other potential sources of bias.

Effects of interventions

See: **Summary of findings for the main comparison** Short-term effects on spasticity, pain and joint mobility

The two included studies evaluated the efficacy of PMs in participants with neurological conditions (spinal cord injury and paratonia). The included studies compared PMs versus no PMs.

- Joint mobility: Only one study measured joint mobility (Harvey 2009). The mean (95% CI) effect on ankle dorsiflexion range of motion was four degrees in favour of the experimental group (95% CI two to six degrees) in people with spinal cord injuries (Analysis 1.1).
- Spasticity: Two studies with a total of 122 participants investigated the short-term effects of PMs on spasticity (Harvey 2009; Hobbelen 2012). Data from the two studies could not be pooled because participants had different diagnoses. In one study (Hobbelen 2012), the mean difference on a tallied Modified

Ashworth Scale for the upper limbs on a zero to 48-point scale was one of 48 points (95% CI minus two to four points; Analysis 2.1), and in the other study (Harvey 2009), the median difference on the Modified Ashworth Scale on a zero to six-point scale for the plantar flexor muscles was zero points (95% CI minus one to zero points). In both studies, a negative between-group difference indicated a reduction in spasticity in the experimental group compared with the control group.

- Pain: Only one study with a total of 102 participants investigated short-term effects on pain following PMs in people with paratonia (Hobbelen 2012). The mean difference on the Pain Assessment Checklist for Seniors With Limited Ability to Communicate Scale on a zero to 24-point scale was -0.4 points in favour of the control group (95% CI -1.4 to 0.6 points; Analysis 3.1).

Neither study reported any adverse events.

The GRADE level of evidence about the effects of PMs on joint mobility, spasticity and pain is very low (see Summary of findings for the main comparison).

DISCUSSION

Summary of main results

The primary objective of this systematic review was to determine whether PMs increase joint mobility in people with existing contractures or those at risk of developing contractures. Only two randomised controlled trials on PMs versus no PMs were identified. Both studies included participants with neurological conditions, but the conditions were not sufficiently similar to enable pooling of data.

Only one of the two studies measured joint mobility, even though PMs are administered primarily to increase joint mobility. In this study (Harvey 2009), a small but statistically significant effect on ankle dorsiflexion range of motion was noted after six months of PMs, but it is unclear whether an effect as low as two degrees or even as high as six degrees is clinically worthwhile. Most clinical trials argue that treatment effects need to be five or 10 degrees to justify the time and cost of most manual therapy interventions. However, a treatment effect as small as two degrees could be therapeutic if the treatment was administered over many, many years, and if the effects of treatment accrued. For example, a between-group difference of just two degrees every six months over a 10-year period would equate to a between-group difference of 40 degrees. Few would dispute the worth of such a treatment effect. But of course it is not known whether the effects of PMs accrue over time. Only a clinical trial conducted over many, many years can answer this question.

Both studies (Harvey 2009; Hobbelen 2012) examined the effect of PMs on spasticity. Neither study reported a statistically significant treatment effect. However, at issue is whether these results provide evidence of no treatment effect or are inconclusive. The distinction relies on examining the lower end of the 95% CI in relationship to a minimally worthwhile treatment effect. The lower end of the 95% CI was minus two of 48 in one trial and minus one of six in the other; both are trivially small reductions in spasticity, and this suggests that both trials have provided evidence that PMs do not affect spasticity. However, it is important to note that initial levels of spasticity were low in both studies. Therefore although the lower end of the 95% CI indicates a trivially small absolute decrease in spasticity, the relative decrease is more substantial. Nonetheless, presumably PMs are worth administering only if they decrease spasticity by at least two of 48 or one of six points. Both studies relied on the Modified Ashworth Scale. Some might argue about the merits of this scale for measuring spasticity. However, it is still widely used, primarily because of its simplicity.

Only one study examined the effect of PMs on pain (Hobbelen 2012). This study indicates that PMs have no effect on pain; however, the quality of the evidence is very low.

Overall completeness and applicability of evidence

This review captures available evidence on the effectiveness of PMs; however, the available evidence is scant, and only two studies were identified for inclusion in the review. The results of the two studies are probably not generalisable to other patient groups or to different joints. Similarly, it is unclear whether the results of the two studies can be used to infer the effectiveness of PMs administered for many years. It is important to note that one study administered PMs for 20 minutes each day to just one joint. This is considerably longer than the procedure that is typically done.

Quality of the evidence

Both of the included studies were of high methodological quality. Both clearly stated methods of randomisation applied and used concealed allocation, blinded assessors and intention-to-treat analysis. One study had no dropouts, and the other had one dropout. Neither study blinded participants or therapists, although this is unlikely to introduce bias because in one study, participants had extensive paralysis, and in the other study, participants were suffering from dementia. They were therefore unlikely to be able to inadvertently bias measures. The GRADE level of evidence showing the effects of PMs on joint mobility, spasticity and pain is very low, primarily because of the paucity of studies in the area. Medium- and long-term effects of PMs on any outcome have not been investigated.

Potential biases in the review process

A common source of bias in systematic reviews is failure to identify all relevant studies. We tried to avoid this source of bias by conducting a comprehensive search of all relevant databases. Despite our efforts, bias may have been introduced by failure to identify unpublished studies. Another source of bias in this systematic review may have been introduced because one of the review authors (LAH) was also an author of one of the included studies. This author did not, however, extract data or assess risk of bias.

Agreements and disagreements with other studies or reviews

No known systematic reviews or other reviews have specifically examined the effectiveness of PMs for the treatment and prevention of contractures. However, two Cochrane systematic reviews have examined the effectiveness of similar interventions targeting joint mobility (Harvey 2010; Katalinic 2010). One review examined the effectiveness of stretch for the treatment and prevention of contractures in people with all types of neurological and non-neurological conditions (35 trials with 1391 participants), and the other looked at the effectiveness

of continuous passive motion following knee arthroplasty (20 trials with 1335 participants). Both reviews concluded that the interventions did not increase joint range of motion. Together, these reviews raise questions about the responsiveness of soft tissue structures surrounding joints to different forms of stretch and passive movement. It has not yet been determined whether soft tissue structures are more responsive to PMs administered through the hands of therapists.

AUTHORS' CONCLUSIONS

Implications for practice

Evidence is insufficient to permit any firm conclusions about the effectiveness of PMs for joint mobility, spasticity or pain among those with contractures or at risk of developing contractures, although PMs may have a small short-term effect on joint mobility (however, the GRADE level of evidence is very low). Medium- and long-term effects of PMs on any outcome have not been investigated, including measures of activity limitations, participation restrictions or quality of life.

Implications for research

Future research is needed to clarify the effectiveness of PMs for the treatment and prevention of contractures. It is estimated that future meta-analyses will require 130 participants to rule in or rule out a treatment effect of five degrees. This conservatively assumes a standard deviation of 10 degrees and does not account for possible correlation of outcomes with baseline measures. It also does not account for the possibility of non-compliance or dropouts.

Research attention directed at achieving a better understanding of the underlying causes of contracture may prove helpful. Useful insights might also be gained from comparing the prevalence of contractures in countries in which PMs are and are not routinely administered on a daily basis to people with long-standing disabilities.

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Harvey 2009

Methods	**Design**: within-subject randomised controlled trial
Participants	**Health condition**: adults with spinal cord injury **Sample size**: experimental group: 20 ankles; control group: 20 ankles[a] **Setting**: community, Australia **Joint of interest**: ankle

Harvey 2009 *(Continued)*

Inclusion criteria: Participants were included if they:

- were wheelchair dependent;
- had mild to moderate ankle stiffness (less than 101 degrees dorsiflexion with a 12-Nm torque applied to the ankle but an arc of at least 15 degrees of motion);
- had paralysis around both knees and ankles; and
- had care givers able to provide the intervention

Exclusion criteria: not reported

Median age (IQR)

- Both groups: 39 (34 to 44)

Gender

- Both groups: 17 M, 3 F

Study dates: not reported

Other: Funding through the University of Sydney's Research and Development Grants Scheme. Conflict of interest not reported

Interventions	Groups included in this review: **Experimental group**: PMs to one randomly allocated ankle of each participant • Experimental ankles of participants were passively moved by participants' care givers for 10 minutes in the morning and 10 minutes in the evening, five days a week for six months. Care givers were given written instructions and training on how to administer PMs • Participants or care givers were required to record in a diary when and for how long PMs were administered • *Total time:* 288 treatments × 10 minutes over a period of six months **Control group**: no PMs to the second ankle of the participant • Control ankles did not receive PMs or stretches for the duration of the trial
Outcomes	**Outcomes included in this review** • Passive ankle dorsiflexion range of motion (degrees) • Ankle plantar flexor spasticity (Modified Ashworth Scale, points) **Other outcomes** • Knee hamstring muscle spasticity (Modified Ashworth Scale, points) **Outcomes testing period** • Tested at baseline and one day after the six-month intervention period. No PMs were administered in the 24 hours before either assessment
Notes	[a]Both ankles of 20 participants were included (a total of 40 ankles). No dropouts from the study were reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...a computer-generated random number sequence was created by a person not involved in recruitment to determine allocation schedule"

Harvey 2009 *(Continued)*

		Comment: Authors have explained the procedure
Allocation concealment (selection bias)	Low risk	Quote: "...each participant's allocation was placed in a sealed, opaque, sequentially numbered envelope to ensure allocation" Comment: Authors have explained the procedure
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: no dropouts
Selective reporting (reporting bias)	Low risk	Comment: all prestated outcomes reported
Other bias	Low risk	Comment: appears free of other bias
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Comment: not possible to blind participants and personnel; however, this was unlikely to bias the results because participants had paralysis and limited ability to influence outcomes
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...all assessors were blinded to group allocation"

Hobbelen 2012

Methods	**Design**: multi-centre single-blinded randomised controlled trial
Participants	**Health condition**: adults with dementia. **Sample size**: experimental group: 48[a]; control group: 54 **Setting**: nursing home residents, Netherlands **Inclusion criteria**: Participants were included if they: • met *DSM-IV-TR* criteria for dementia; • were diagnosed with paratonia; and • had moderate to severe paratonia defined as a score on the MAS of at least two in at least one limb **Exclusion criteria**: Participants were excluded if they: • had been prescribed any antipsychotic medication; • had received PMs less than four weeks before the start of the trial; • had an unstable health problem or disease before admission or during the trial[b]; or • showed signs of challenging behaviour towards the therapist and or the intervention **Median age (range)** • Experimental group: 84 (74 to 98) • Control group: 83 (67 to 97) **Gender** • Experimental group: 9 M, 38 F • Control group: 9 M, 45 F

Hobbelen 2012 *(Continued)*

	Study dates: Data collection occurred between April 2007 and April 2009 **Other**: Funding through the Vitalis WoonZorg Groep Eindhoven, the Netherlands. The first author was a part-time employee at the Vitalis WoonZorg Groep
Interventions	Groups included in this review: **Experimental group**: PMs to all limbs • Participants were comfortably supine in bed when therapists started PMs with the left arm, moving the shoulder and subsequently the elbow. Next, the same movements were made in the right arm. Subsequently, the left leg and the right leg were moved, with the hip and knee in flexion, extension and abduction/external rotation, although with no spinal movements • *Total time:* 12 sessions × 20 minutes over a period of four weeks **Control group**: no PMs to limbs • Participants were comfortably supine in the bed while therapists sat silently alongside the bed for an equal duration of time as required to administer PMs to experimental participants
Outcomes	**Outcomes included in this review** • Severity of paratonia in upper limbs (tallied Modified Ashworth Scale, points) • Pain (Pain Assessment Checklist for Seniors With Limited Ability to Communicate Scale, points) **Other outcomes** • Severity of paratonia in lower limbs (tallied Modified Ashworth Scale, points) • Care giver burden (Clinical Global Impression of Change—change, points) • Functional status of the participant (Modified Patient Specific Complaints, points) **Outcomes testing period** Tested at baseline (one day before commencement of treatment), after two weeks and after four weeks (one day after treatment 12)
Notes	[a]102 participants were randomly assigned, but one dropout was reported. Therefore, data from only 101 participants were included in the analyses (Analysis 2.1 and Analysis 3.1) [b]It is not clear how a health condition occurring "during the trial" (so after randomisation) could be part of the exclusion criteria

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "...computerized and concealed block randomisation (block size four)" Comment: Authors have explained the procedure
Allocation concealment (selection bias)	Low risk	Quote: "The randomisation code was only available to the assigned therapists and was kept secret from all other personnel involved, including the primary investigator" Comment: Authors have explained the procedure, although the fixed block size of four may have enabled those recruiting to guess some participants' allocation if they were aware of this
Incomplete outcome data (attrition bias) All outcomes	Low risk	Comment: one of 48 in the experimental group

Hobbelen 2012 *(Continued)*

Selective reporting (reporting bias)	Low risk	Comment: all prestated outcomes reported
Other bias	Low risk	Comment: appears free of other bias
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Comment: not possible to blind participants and personnel; however, this was unlikely to bias the results because participants were in the advanced stages of dementia with limited ability to influence outcomes
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Quote: "...all assessors were blinded to group allocation"

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Bennell 2005	Not clear whether PMs were administered to experimental participants
Cadenhead 2002	Not a randomised controlled trial
Carmeli 2006	PMs administered through device
Cheng 2013	PMs administered through device
Ferrarello 2011	Systematic review of active interventions
Gebhard 1993	Animal study
Goldsmith 2002	Compared active, passive range of motion exercises versus control group; therefore cannot isolate the effects of PMs
Hoeksma 2004	No PMs administered
Jesudason 2002	No PMs administered
Krause 2008	PMs administered through device
Litmanovitz 2007	PMs not administered for treatment and prevention of contractures
Lorentzen 2012	Compared a neural tension technique versus PMs (PMs were "within a small range of motion" and were administered to have an effect similar to that of placebo)
Nilgun 2011	Not a randomised controlled trial
Shin 2012	Not a randomised controlled trial

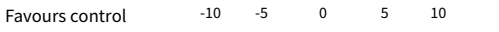
DATA AND ANALYSES

Comparison 1. Joint mobility—short-term effects

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Spinal cord injury	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1 Joint mobility—short-term effects, Outcome 1 Spinal cord injury.

Study or subgroup	Control		Experimental		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI	Random, 95% CI
Harvey 2009	20	4.9 (3.4)	20	0.9 (4.4)		4.05[1.64,6.46]

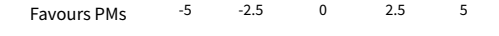


Comparison 2. Spasticity—short-term effects

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Paratonia	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Analysis 2.1. Comparison 2 Spasticity—short-term effects, Outcome 1 Paratonia.

Study or subgroup	Control		Experimental		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI	Fixed, 95% CI
Hobbelen 2012	54	-1.2 (6.9)	47	-2.3 (7.9)		1.1[-1.81,4.01]

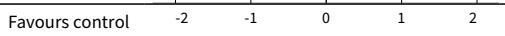


Comparison 3. Pain—short-term effects

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Paratonia	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

Analysis 3.1. Comparison 3 Pain—short-term effects, Outcome 1 Paratonia.

Study or subgroup	Control		Experimental		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI	Fixed, 95% CI
Hobbelen 2012	54	-0.8 (2.5)	47	-0.4 (2.4)		-0.4[-1.36,0.56]



APPENDICES

Appendix 1. Example of eligible participants

Eligible participants, those with existing contractures or at risk of contractures, include, but will not be restricted to, people:

- with neurological conditions (e.g. stroke, multiple sclerosis, spinal cord injury, traumatic brain injury, Guillain-Barré syndrome, Parkinson's disease);
- with advanced age (e.g. frailty);
- with underlying joint or muscle pathology and disease processes (e.g. inflammatory arthritis, osteoarthritis); and
- who are unconscious or semi-conscious following surgery, an acute injury or illness (e.g. participants in intensive care).

Appendix 2. Search strategies

Cochrane Injuries Group Specialised Register
#1 ((((Joint* or muscle*) and (mobili* or movement* or spastic* or rigid* or elastic* or stiff* or extensib* or flexib* or shorten*))) OR ("Range of motion" or contracture*)) AND (INREGISTER) [REFERENCE] [STANDARD]
#2 ((physical or motion or movement or passiv* or CPM or exercise or "Continuous Passive")) [REFERENCE] [STANDARD]
#3 therap* OR (passiv* and (movement* or motion)) [REFERENCE] [STANDARD]
#4 #2 AND #3 [REFERENCE] [STANDARD]
#5 (stretch* and (body or arm* or leg* or limb* or joint* or muscle* or torso or trunk)) [REFERENCE] [STANDARD]
#6 ("Muscle stretching exercise*" or "Resistance training" or "musculoskeletal manipulation*" or "Exercise Movement Technique*" or splint* or "orthotic device*" or yoga) [REFERENCE] [STANDARD]
#7 #4 OR #5 OR #6 [REFERENCE] [STANDARD]
#8 #1 AND #7 [REFERENCE] [STANDARD]

Cochrane Central Register of Controlled Trials (CENTRAL)
#1MeSH descriptor Contracture explode all trees
#2MeSH descriptor Muscle Rigidity explode all trees
#3MeSH descriptor Muscle Spasticity explode all trees
#4MeSH descriptor Elasticity explode all trees with qualifier: PH
#5MeSH descriptor Range of Motion, Articular explode all trees
#6contracture* or "Range of motion" or ((Joint* or muscle*) near3 (mobili* or movement* or spastic* or rigid* or elastic* or stiff* or extensib* or flexib* or shorten*))
#7(#1 OR #2 OR #3 OR #4 OR #5 OR #6)
#8MeSH descriptor Exercise Therapy, this term only
#9MeSH descriptor Muscle Stretching Exercises, this term only
#10MeSH descriptor Resistance Training, this term only
#11MeSH descriptor Physical Medicine, this term only
#12MeSH descriptor Physical Therapy Modalities, this term only
#13MeSH descriptor Motion Therapy, Continuous Passive explode all trees
#14MeSH descriptor Musculoskeletal Manipulations explode all trees
#15MeSH descriptor Exercise Movement Techniques explode all trees
#16MeSH descriptor Splints explode all trees
#17MeSH descriptor Orthotic Devices explode all trees
#18MeSH descriptor Yoga explode all trees
#19(physical near3 therap*) or (motion near3 therap*) or (movement near3 therap*) or (passiv* near3 movement*) or (passiv* near3 motion) or (CPM near3 therap*)
#20(stretch*) near3 (body or arm* or leg* or limb* or joint* or muscle* or torso or trunk)
#21(#8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20)
#22(#7 AND #21)

MEDLINE (Ovid SP)
1. exp Contracture/
2. exp Muscle Rigidity/
3. contracture*.ab,ti.
4. exp Muscle Spasticity/
5. exp Elasticity/ph [Physiology]
6. exp "Range of Motion, Articular"/ph [Physiology]
7. ((Joint* or muscle*) adj3 (mobili* or movement* or spastic* or rigid* or elastic* or stiff* or extensib* or flexib* or shorten*)).ab,ti.
8. "Range of motion".ab,ti.
9. or/1-8

10. Exercise therapy/
11. Muscle stretching exercises/
12. Resistance training/
13. Physical Medicine/
14. physical therapy modalities/
15. exp Motion Therapy, Continuous Passive/
16. exp musculoskeletal manipulations/
17. exp Exercise Movement Techniques/
18. exp Splints/
19. exp Orthotic devices/
20. exp Yoga/
21. ((physical adj therap*) or (motion adj therap*) or (movement adj therap*) or (passiv* adj movement*) or (passiv* adj motion) or (CPM adj therap*)).ab,ti.
22. (stretch* adj3 (body or arm* or leg* or limb* or joint* or muscle* or torso or trunk)).ab,ti.
23. or/10-22
24. 9 and 23
25. randomi?ed.ab,ti.
26. randomized controlled trial.pt.
27. controlled clinical trial.pt.
28. placebo.ab.
29. clinical trials as topic.sh.
30. randomly.ab.
31. trial.ti.
32. 25 or 26 or 27 or 28 or 29 or 30 or 31
33. (animals not (humans and animals)).sh.
34. 32 not 33
35. 24 and 34

EMBASE (Ovid SP)
1.exp muscle contracture/
2.exp Muscle Rigidity/
3.contracture*.ab,ti.
4.exp spasticity/
5.exp physical mobility/
6.((Joint* or muscle*) adj3 (mobili* or movement* or spastic* or rigid* or elastic* or stiff* or extensib* or flexib* or shorten*)).ab,ti.
7."Range of motion".ab,ti.
8.exp muscle strength/
9.or/1-8
10.Exercise therapy/
11.Muscle stretching exercises/
12.Resistance training/
13.Physical Medicine/
14.physical therapy modalities/
15.exp Motion Therapy, Continuous Passive/
16.exp musculoskeletal manipulations/
17.exp Exercise Movement Techniques/
18.exp Splints/
19.exp Orthotic devices/
20.exp Yoga/
21.((physical adj therap*) or (motion adj therap*) or (movement adj therap*) or (passiv* adj movement*) or (passiv* adj motion) or (CPM adj therap*)).ab,ti.
22.(stretch* adj3 (body or arm* or leg* or limb* or joint* or muscle* or torso or trunk)).ab,ti.
23.or/10-22
24.9 and 23
25.exp Randomized Controlled Trial/
26.exp controlled clinical trial/
27.randomi?ed.ab,ti.
28.placebo.ab.
29.*Clinical Trial/
30.randomly.ab.
31.trial.ti.
32.25 or 26 or 27 or 28 or 29 or 30 or 31

33.exp animal/ not (exp human/ and exp animal/)
34.32 not 33
35.24 and 34
36.Limit 35 to exclude medline journals

PsycINFO (Ovid SP)
1. muscle contractions/
2. exp Muscle Spasms/
3. "range of motion"/
4. contracture*.ab,ti.
5. ((Joint* or muscle*) adj3 (mobili* or movement* or spastic* or rigid* or elastic* or stiff* or extensib* or flexib* or shorten*)).ab,ti.
6. "Range of motion".ab,ti.
7. 1 or 2 or 3 or 4 or 5 or 6
8. exercise/
9. exp Movement Therapy/
10. physical treatment methods/
11. exp Yoga/
12. ((physical adj therap*) or (motion adj therap*) or (movement adj therap*) or (passiv* adj movement*) or (passiv* adj motion) or (CPM adj therap*)).ab,ti.
13. (stretch* adj3 (body or arm* or leg* or limb* or joint* or muscle* or torso or trunk)).ab,ti.
14. 8 or 9 or 10 or 11 or 12 or 13
15. 7 and 14
16. exp clinical trials/
17. exp placebo/
18. exp treatment effectiveness evaluation/
19. exp mental health program evaluation/
20. exp experimental design/
21. exp prospective studies/
22. clinical trial*.ab,ti.
23. controlled clinical trial.ab,ti.
24. randomi?ed controlled trial.ab,ti.
25. randomi?ed.ab,ti.
26. placebo.ab.
27. randomly.ab.
28. trial.ti.
29. ((singl* or doubl* or trebl* or tripl*) adj3 (blind* or dummy or mask*)).ab,ti.
30. ((crossover or clin* or control* or compar* or evaluat* or prospectiv*) adj3 (trial* or studi* or study)).ab,ti.
31. 16 or 17 or 18 or 19 or 20 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30
32. exp animals/
33. exp human females/
34. exp human males/
35. 33 or 34
36. 32 not (32 and 35)
37. 31 not 36
38. 15 and 37

ISI Web of Science: Science Citation Index—Expanded (SCI-EXPANDED); Social Sciences Citation Index (SSCI); Conference Proceedings Citation Index—Science (CPCI-S); Conference Proceedings Citation Index—Social Sciences & Humanities (CPCI-SSH)
#9#8 AND #7 AND #6
#8 TS=((physical or motion or movement or passiv* or CPM or exercise or "Continuous Passive") NEAR/3 (therap*)) OR TS=((passiv*) NEAR/3 (movement* or motion)) OR TS=((stretch*) NEAR/3 (body or arm* or leg* or limb* or joint* or muscle* or torso or trunk)) OR TS=(Muscle stretching exercise* or Resistance training or musculoskeletal manipulation* or Exercise Movement Technique* or splint* or orthotic device* or yoga)
#7 TS=((Joint* or muscle*) NEAR/3 (mobili* or movement* or spastic* or rigid* or elastic* or stiff* or extensib* or flexib* or shorten*)) OR TS=(Range of motion or contracture*)
#6 #5 AND #4
#5 TS=(human*)
#4 #3 OR #2 OR #1
#3 TS=((singl* OR doubl* OR trebl* OR tripl*) SAME (blind* OR mask*))
#2 TS=(controlled clinical trial OR controlled trial OR clinical trial OR placebo)
#1 TS=(randomised OR randomized OR randomly OR random order OR random sequence OR random allocation OR randomly allocated OR at random OR randomized controlled trial)

WHAT'S NEW

Date	Event	Description
3 January 2014	Amended	Minor copy edits have been made to the text.

CONTRIBUTIONS OF AUTHORS

RKRP conceived of the review, coordinated the review, culled the searches, extracted the data, performed the analyses, wrote the first draft and edited the final draft. NS culled the searches, extracted the data and edited drafts. LAH culled the searches, checked all data extracted, created the Summary of findings tables, contributed to the write-up of the review and edited the final draft. The search strategy was formulated through consultation with the Cochrane Injuries Group Trials Search Co-ordinator.

DECLARATIONS OF INTEREST

None known.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

These are the differences between the protocol and the review.

- The protocol states that we would "search the Internet to identify relevant websites and conference proceedings". This was not done.
- The protocol states: "Two review authors (RKRP and NS) will independently screen the results of the search for relevant articles based on the title and abstract." This was done by the three review authors (RKRP, NS and LAH).
- The protocol states: "Data will be extracted by three review authors (RKRP, NS and LAH) independently." The data were extracted independently by two review authors (RKRP and NS) because the third review author (LAH) was an author on an included trial. LAH and J Bowden checked all data extracted.
- The protocol states: "The summary of findings tables will include the following outcomes: joint mobility, pain, activity limitations and quality of life". The summary of findings tables include joint mobility, spasticity and pain because neither of the two included trials included measures of activity limitations or quality of life.
- The protocol states: "Adverse outcomes will be grouped in the following ways: joint subluxations or dislocations, heterotopic ossification, autonomic dysreflexia, fractures, pain and muscle tears". Pain was removed from this list because it was a secondary outcome.

INDEX TERMS

Medical Subject Headings (MeSH)

Ankle Joint; Contracture [prevention & control] [*therapy]; Manipulation, Orthopedic [*methods]; Muscle Spasticity [therapy]; Pain Measurement; Randomized Controlled Trials as Topic; Range of Motion, Articular

MeSH check words

Humans