Rehabilitation interventions for foot drop in neuromuscular disease (Review)

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[Intervention Review]

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Cochrane Database of Systematic Reviews, Issue 2, 2009 (Status in this issue: *Unchanged*)

DOI: 10.1002/14651858.CD003908.pub2
This version first published online: 18 April 2007 in Issue 2, 2007.
Last assessed as up-to-date: 4 February 2007. (Help document - Dates and Statuses explained)

This record should be cited as: Sackley C, Disler PB, Turner-Stokes L, Wade DT. Rehabilitation interventions for foot drop in neuromuscular disease. *Cochrane Database of Systematic Reviews* 2007, Issue 2. Art. No.: CD003908. DOI: 10.1002/14651858.CD003908.pub2.

ABSTRACT

Background

"Foot drop" or "Floppy foot drop" is the term commonly used to describe weakness or contracture of the muscles around the ankle joint. It may arise from many neuromuscular diseases.

Objectives

To conduct a systematic review of randomised trials of treatment for footdrop resulting from neuromuscular disease.

Search strategy

We searched the Cochrane Neuromuscular Disease Group Trials Register (July 2005), MEDLINE (January 1966 to July 2005), EMBASE (January 1980 to July 2005), AMED (January 1985 to July 2005) and CINAHL databases (January 1982 to July 2005).

Selection criteria

Randomised and quasi-randomised trials of physical, orthotic and surgical treatments for footdrop resulting from lower motor neuron or muscle disease and related contractures were included. People with primary joint disease were excluded. Interventions included a 'wait and see' approach, physiotherapy, orthotics, surgery and pharmacological therapy. The primary outcome measure was ability to walk whilst secondary outcome measures included dorsiflexor torque and strength, measures of 'activity' and 'participation' and adverse effects.

Data collection and analysis

Methodological quality was evaluated by two authors using the van Tulder criteria. Three studies with altogether 139 participants were included in the review. Heterogeneity of the studies precluded pooling the data.

Main results

Early surgery did not significantly affect walking speed in a trial including 20 children with Duchenne muscular dystrophy. After one year, the mean difference (MD) of the 28 feet walking time was 0.00 seconds (95% confidence interval (CI) -0.83 to 0.83) and the MD of the 150 feet walking time was -2.88 seconds, (95% CI -8.18 to 2.42). In a trial with altogether 26 participants with Charcot-Marie-Tooth disease (hereditary motor and sensory neuropathy), long-term strength training significantly increased walking speed on a 6 metre timed walk (MD -0.70 seconds, 95% CI -1.17 to -0.23) but not on a 50 metre timed walk (MD -1.9 seconds, 95% CI -4.09 to 0.29). In a trial of a 24-week strength training programme in 28 participants with myotonic dystrophy, there was no significant change in walking speed on either a 6 or 50 metre walk.

Authors' conclusions

Using the primary outcome of ability to walk, only one study demonstrated a positive effect and that was an exercise programme for people with Charcot-Marie-Tooth disease. Surgery was not significantly effective in children with Duchenne muscular dystrophy. More evidence generated by methodologically sound trials is required.

PLAIN LANGUAGE SUMMARY

Rehabilitation for foot drop (weakness or muscle shortening (contracture) at the ankle joint)

Foot drop is the term commonly used to describe weakness or contracture of the muscles at the ankle joint. It may arise from many neuromuscular diseases. Interventions might include a 'wait and see' approach, physiotherapy, orthotics (appliances), surgery or drug therapy. The review identified three randomised controlled trials which met the criteria for inclusion in the review, involving 139 participants in total. In one trial involving people with Charcot-Marie-Tooth disease, also known as hereditary motor and sensory neuropathy, exercise had a significant beneficial effect on walking ability. A trial of surgery on the Achilles tendon in boys with Duchenne muscular dystrophy had no significant effect on walking ability. Data from a third trial of exercise in people with facioscapulohumeral muscular dystrophy showed no positive effect on ankle strength. Further randomised controlled trials are needed.

BACKGROUND

This Cochrane Review investigated the problem of weakness and contracture of the muscles around the ankle joint, which arise from neuromuscular diseases affecting the lower motor neuron (LMN) or muscle. This condition is commonly called foot drop or 'floppy foot drop' (Donaghy 2001). Foot drop can have a profound effect on gait. In moderate cases, the front of the foot drops to the floor after heel strike, preventing the striding leg from swinging through, while in severe cases toe strike may precede heel strike and the toe may catch the ground during swing-through of the leg, which may lead to tripping or falling. Using the terminology of the International Classification of Function, Disability and Health (WHO 2001), foot drop is thus an 'Impairment of Body Structure' that may markedly influence the 'Activities' and 'Participation' of the affected individual.

The major cause of foot drop is weakness of the muscles of ankle dorsiflexion, primarily tibialis anterior, but with important contributions from weakness of the long extensors of the toes (extensor hallucis longus and extensor digitorum longus). A significant, secondary effect of this weakness is shortening and contracture of the Achilles tendon, which is formed by the merging of the tendinous portions of the major muscles of plantar flexion, the gastrocnemius and soleus. However, the ankle is a complex bipartite joint, able to move in four directions: dorsiflexion, plantar flexion, eversion and inversion. Many of the conditions which cause weakness of the dorsiflexors, also affect the muscles of eversion (peroneus tertius and peroneus longus) and inversion (tibialis posterior). The foot drop syndrome therefore often also incorporates weakness of these muscles, and associated contracture of their antagonist muscle tendons. The exact contribution may differ between conditions.

This review, therefore, has greater clinical relevance if the term Achilles tendon is seen as convenient shorthand for all the tendons acting around the ankle joint, which may be involved when foot drop occurs. Similarly we included research that describes weakness of the other muscles which move the ankle, not only isolated involvement of the dorsiflexion agonists, as long as the lower motor neuron was primarily affected. Conversely this review specifically excluded ankle weakness secondary to upper motor neuron lesions, and soft tissue contractures associated with non-neurological disease, such as arthritis or burns.

Aetiology of foot drop and contracture

Floppy foot drop can result from damage to any part of the lower motor neuron between the lumbosacral spine and the muscles of ankle dorsiflexion. Classified anatomically, a non-exhaustive list of the common causes would include:

- Anterior horn cell of the spinal cord (eg poliomyelitis and motor neuron disease).
- Motor nerve root eg cauda equina lesions and involvement of the lumbosacral nerve roots as they exit from the spine, usually associated with intervertebral disc prolapse.
- Peripheral motor nerve as part of a diffuse peripheral neuropathy (including Guillain-Barré syndrome, chronic inflammatory demyelinating polyneuropathy).
- Hereditary motor and sensory neuropathy (for example Charcot-Marie-Tooth disease).
- Involvement of specific peripheral nerves derived from the sciatic plexus:

(a) the sciatic nerve as it passes from the pelvis through the sciatic notch, past the hip joint and into the leg (eg with pelvic fractures, buttock injections, and following pelvic surgery and hip replacement).
(b) the peroneal nerve (which supplies all the evertors and dorsiflexors of the ankle), often as a result of lower limb fractures where the nerve traverses the fibular head.

- Primary muscle disease eg muscular dystrophy (including Duchenne, Becker, facioscapuloperoneal and Emery-Dreifuss dystrophies).

Incidence and prevalence of foot drop

The incidence and prevalence is hard to establish. Geboers (Geboers 2001a) suggested one new case per 6000 people each year, based on referrals of newly affected patients to a Neurology and Rehabilitation Service in Heerlen, Netherlands, serving an estimated population of 300,000. As the majority of the cases had either peroneal nerve palsy or prolapsed discs, and the referral rate in the area was not known, this may well have been an underestimate. Any neurological rehabilitation unit sees a significant number of affected patients annually.

Treatment modalities

Despite the frequency of foot drop, and the serious effect that it has on gait and general function, the literature provides little direction as to its treatment. Recent comprehensive textbooks on neurology and neurorehabilitation tend to address the matter only briefly, offering various therapeutic options in a non-critical way; thus 'it is important to prevent contracture of the Achilles tendon, and the foot should be splinted in dorsiflexion day and night, and the ankle moved through its full range passively' (Donaghy 2001).

Several therapeutic approaches are known to be used in practice including 'wait and see' (ie no intervention), physiotherapy, surgery and drug treatment.
The authors could not locate any recent, formal review of this topic in the published literature that critically compares these approaches. This review aims to fill this gap as a basis for making clinical decisions, identifying the need for trials, and maintaining an up to date record of such research in the future.

OBJECTIVES

The objective was to review systematically all randomised and quasi-randomised trials of the treatment of foot drop resulting from lower motor neuron or muscle disease, including the prevention and treatment of Achilles tendon contracture, and other soft tissue contractures that develop in association with such foot drop.

METHODS

Criteria for considering studies for this review

Types of studies

We included all randomised controlled trials (RCTs) and quasi-randomised trials of physical, orthotic and surgical approaches in the treatment of lower motor neuron foot drop, and the prevention and treatment of Achilles tendon contracture, and other soft tissue contractures that develop in association with such foot drop. Quasi-randomised trials are those trials in which treatment allocation was intended to be random, but might have been biased (eg alternate allocation).

Types of participants

We included studies pertaining to participants of all ages who were described as having:

- lower motor neuron or 'floppy' foot drop, whether the diagnosis was made clinically or through nerve conduction studies and EMG; and/or
- contractures of the Achilles tendon (or other associated tendons) that had developed secondary to the foot drop, and which affected the range of motion of the ankle.

We specifically excluded participants with primary joint or soft tissue problems (eg arthritis or burns).

Types of interventions

We included all therapeutic approaches known to be used in practice, whether used alone, or within the context of a multidisciplinary rehabilitation programme, ie:

- A non-interventionist approach based on the expectation either that recovery will occur equally well without treatment or that the deficit does not warrant treatment, at least at present.
- Physiotherapy, which may have several components:

(a) maintenance of passive range of motion;
(b) attempts to improve active muscle movement through isotonic or isometric exercise (Germain 1995; Rozier 1979);
(c) attempts to improve active muscle movement through electrical nerve stimulation, often timed to occur during foot contact using a switch (ie acting as an orthosis) and often referred to as Functional Electrical Stimulation.

- Orthotics, used to splint the joint in a functional position. At rest, these prevent the foot falling into a position of forced plantar flexion (which could cause a contracture with a major effect on gait); the risk of tripping while walking is also minimised, with a positive effect on patient safety. However, some debate has developed as to whether orthotics will enhance recovery of the paretic muscle by facilitating walking, or retard recovery through immobilisation and disuse atrophy (Geboers 2001a; Geboers 2001b; Geboers 2002; Tropp 1995).
- Surgery of various types, including tendon lengthening procedures and transfers (Wiesseman 1981), and other orthopaedic interventions such as subtalar arthrodesis (Jaivin 1992). Surgical management of the primary cause, such as lumbar disc surgery for prolapse or decompression of the peroneal nerve, is outside the scope of this review.
- Pharmacological therapy was included as some modalities (such as nerve growth factor administration) may well become important in the future. However where this has formed the topic for another Cochrane review, the authors will defer to its content, rather than reviewing the topic independently.

Types of outcome measures

The primary outcome measure that was considered was a test of walking ability, using a validated objective test, limited either by distance (eg the 10 metre test, with and without stairs) or time (eg the six minute endurance test).
However we also included studies that based their findings on other outcome measures provided they were measured using a scale validated in the relevant population, including:

- Active and passive range of motion of the ankle (measured using a goniometer or inclinometer);
- Dorsiflexor torque and strength;
- 'Activities' (WHO 2001) measured with validated tools, and orientated to either personal Activities of Daily Living (ADL) (eg the Barthel ADL Index), domestic or community ADL;
- Measures of 'participation' (WHO 2001): eg ability to work;
- Quality of life.
- Cost effectiveness.
- Adverse effects attributable to the intervention eg ulceration preventing use of an orthodox device and falls.

Search methods for identification of studies

Electronic searches

We searched the Cochrane Neuromuscular Disease Group Trials register (searched July 2005), MEDLINE (from January 1966 to July 2005), EMBASE (from January 1980 to July 2005), CINAHL (from January 1982 to July 2005), AMED (from January 1985 to July 2005). The British Nursing Index and Royal College of Nursing Journal of Databases was also studied (from January 1985 to July 2005).
The following search terms were used:

- foot drop OR floppy foot drop
- ankle contracture
- Achilles tendon contracture OR shortening
- exercise OR physiotherapy AND lower motor neuron lesions
- orthotics AND lower motor neuron lesions
- nerve stimulation AND lower motor neuron lesions
- surgery AND lower motor neuron lesions

In the original protocol we proposed to contact authors, however we were only able to contact Dr E van der Kooi and Dr E Lindeman.

Searching other resources

See Appendix 1, Appendix 2, Appendix 3, Appendix 4 and Appendix 5.

Data collection and analysis

Three authors checked the titles and abstracts of the articles identified by the search (CS, LTS, PD). The same authors extracted data using a specially designed form, assessed the methodological quality of the selected articles using a standardised grading system, and independently decided upon inclusion (CS, LTS, PD). No disagreement between authors was encountered.

Selection of studies

Studies were included if:

- they were randomised or quasi-randomised.
- over 60% of participants included initially had follow up data.
- the control group did not exercise the leg systematically.

Studies were excluded if:

- the study protocol was not adhered to.
- the groups varied greatly at entry (baseline) and there was no statistical adjustment for this.

Assessment of methodological quality

Assessment of methodological quality using a standardised grading system is essential if the methodological quality of studies is to be reviewed objectively. Many previous Cochrane reviews have based their assessments on the three essential criteria described by Jadad et al (Jadad 1996) including method of treatment allocation, whether trials have ensured an intention-to-treat analysis and attempted concealment of allocation.

These criteria were developed for interventional trials of drug therapy, but are less easy to apply to trials of rehabilitation interventions where, as discussed by Turner-Stokes (Turner-Stokes 2005), blinding of subjects and therapists is rarely possible as they are aware of when treatment is being implemented and received. An alternative checklist, the van Tulder scale was therefore employed (van Tulder 1997). The scale includes the three Jadad criteria, but adds further criteria to reach a total of nineteen (11 criteria for internal validity, 6 descriptive criteria and 2 statistical criteria) (Table 1). This approach was used for methodological evaluation in this review, and on this basis an RCT was considered to be of high methodological quality if there were positive scores on at least six out of eleven internal validity items, at least three out of six descriptive items and at least one out of two statistical items.

Table 1. Scoring criteria using the method of van Tulder 1997

Criterion	Score positive if:
Eligibility criteria specified	A list of inclusion / exclusion criteria was explicitly stated.
Method of randomisation	A random (unpredictable) assignment sequence was used.
Treatment allocation concealment	Assignment was concealed from the investigators.
Similarity of baseline characteristics	The study groups were comparable at baseline for the important prognostic parameters.

Table 1. Scoring criteria using the method of van Tulder 1997 (*Continued*)

Intervention and control specifically described	Details were given of the programme, including disciplines involved and treatment duration.
Blinding of observers	Observers were blinded regarding treatment allocation and standardised assessment measures were used to structure the interviews. It was scored negative if only self-reported (questionnaire) outcomes were used and no observer outcomes.
Co-interventions avoided or equal	Co-interventions were avoided in the design of the study or were equally divided among the intervention groups.
Compliance	Compliance was measured and satisfactory in all study groups.
Outcome measures relevant	Outcome measures reflected disability (activity) or participation as relevant to the intervention.
Withdrawal rate acceptable	The number of randomised patients minus the number of patients at the main moment of effect measurement divided by all randomised patients and multiplied by 100, was less than 20% for short-term outcomes or less than 30% for long-term outcomes.
Short-term outcome measurement	Outcomes were measured at the end of treatment (e.g. admission to discharge) or within 6 months of the end of treatment.
Long-term outcome measurement	Outcomes were measured at 1 year or more.
Intention-to-treat analysis	All randomised patients were included in the analysis (minus missing values), irrespective of non-compliance and co-interventions. If loss to follow-up was substantial (20% or more), an intention-to-treat analysis as well as an alternative analysis, which accounts for missing values (e.g. a worst-case analysis), should have been performed.
Point estimates and measures of variability	A mean or median figure was given for each important outcome parameter, together with a measures of variability such as standard deviation, standard error of the mean, or 95% confidence intervals.

Blinding

In the rehabilitation context, it is seldom possible to blind either participants or therapists to the therapeutic intervention. However it is usually possible to blind the assessor.

Concealment of treatment allocation

Examples of 'adequate procedures' for treatment allocation concealment are:
• assignment of treatment at random by an independent person not responsible for determining the eligibility of the participants.
• a centralised randomisation scheme - eg a computer system providing allocations in a locked, unreadable file that could be assessed only after inputting the characteristics of an enrolled participant.
• numbered or coded containers, or sequentially numbered, sealed, opaque envelopes.
If the concealment of treatment allocation was described only as random or randomised, it was considered unclear.

Adverse effects

Adverse effects of rehabilitation are potentially possible, but are considered infrequent by clinicians. The absence of adverse effects is therefore seldom specifically recorded. Nonetheless we looked for recording of adverse events.

Analysis and data synthesis

Meta-analysis can be undertaken only if the study populations, interventions, outcomes and study designs are agreed to be sufficiently consistent to allow pooling of data. There was, as will

be seen, too much clinical heterogeneity among the studies with regard to participants (diagnosis and severity of disease), intervention (duration frequency and setting) and outcome measures (diversity of assessment tools) to make such analyses possible in this review.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Included studies

The total number of references the search yielded was as follows: NMD Group specialised register 17 references, AMED 15 references, CINAHL 52 references, EMBASE 44 references, MEDLINE 17 references. The number studied in full text was 12. A PhD thesis reporting a study published in two articles was not reviewed separately. There was no disagreement between the two authors in terms of the inclusion and exclusion of studies. Three studies were included (reported in six publications), one including boys with Duchenne muscular dystrophy, one adults with facioscapulohumeral muscular dystrophy and one with participants who had either myotonic dystrophy or Charcot-Marie-Tooth disease, and the two groups have been discussed separately below.

Duchenne muscular dystrophy

Surgical intervention

Manzur 1992 studied the effects of surgical intervention in boys with Duchenne muscular dystrophy (DMD). Participants, aged four to six years, were randomised to either conservative treatment or surgical intervention. Surgery used Rideau's approach (Rideau 1986). This consists of open release at the hip of the sartorius muscle, the superficial head of the rectus femoris muscle and tensor fasciae lati. The Achilles tendon is lengthened and hamstring tendons released if there are knee flexion contractures. Participants were transferred to hospital after three days where they were mobilised by physiotherapy between the third and sixth day after surgery. They were discharged home four to six days following surgery, walking without orthotic support, and without routine passive stretching or physiotherapy. The control group continued with regular passive stretching of the Achilles tendon, iliotibial bands and hip flexors, performed daily by the parents after demonstration by the physiotherapist. All boys were assessed at three month intervals in the first year, and twice annually thereafter.

Outcome evaluation was based on walking time over 28 and 150 feet, muscle strength (rated using the Medical Research Council Scale (MRC 1943), myometry of five muscle groups in the legs and two in the arms, the timing of Gowers' manoeuvre, motor ability (based on 20 activities), measurement of contractures, gait analysis, ultrasound of the quadriceps femoris muscle. Needle muscle biopsy of the vastus lateralis muscle was carried out before and after operation. Clinical photographs and video recordings of movement quality were also taken.

Twenty-eight boys were assessed for recruitment. Eight were rejected. Three were too weak, two were unable to co-operate with assessments, the parents of two boys refused consent and one had experienced complications during previous surgery. Twenty boys were therefore randomised into the two groups defined above (n = 10 in each group). Surgery was tolerated well in the surgical group with all participants discharged within a week of surgery. The motor ability score and Medical Research Council Scale scores were similar between the two groups at baseline. All participants were followed up for a minimum of one year, the time used for follow-up analysis. Four of the ten operated boys showed initial improvement in qualitative gait analysis. This improvement was defined by the authors as "particularly related to improved heel strike" and was apparently "still noticeable up to a year after surgery". Formal gait analysis revealed no significant difference between the two groups at one year on any of the six parameters studied (step and stride length, swing phase duration, double support time, cadence and velocity). No difference between groups was found in Medical Research Council Scale score, myometry or Gower's times at follow-up.

Achilles tendon contractures were all severe in the surgical group and were reduced by surgery from a mean of 26° to 16° at three months. However, two of the ten boys developed contractures again within one year of surgery. Iliotibial band contractures were reduced from a mean of 6° to 1° at one year follow-up.

Ultrasound scanning of the muscles which was found to be abnormal in all participants before surgery, revealed no significant change or differences between groups at one year follow-up.

At two years, five boys in the control group and six in the surgical group were reassessed. Recurrences of Achilles tendon contractures were noted in five of the six operated boys on at least one side. One boy lost independent ambulation by 2.5 years after surgery.

The authors concluded that "there was no measurable difference between our surgical and conservative groups and our study has not shown any benefit of early surgery in relation to muscle strength and function". They noted that contractures could be reduced in the short-term but recurred in at least seven of the 10 boys within one to two years of surgery.

A long-term follow up of the same group of 20 boys a mean of nine years after surgery was published as an abstract for the Fourth International Congress of the World Muscular Dystrophy Society in 1999, but the number of participants at follow up was not specified. The follow-up revealed recurrence of contractures in all boys in the surgical group and authors concluded that early limb surgery demonstrated no functional benefit. The Rideau operation was not therefore recommended as routine treatment for this

condition.

Facioscapulohumeral muscular dystrophy

Exercise and strength training

Moderate severe progressive strength training in participants with facioscapulohumeral muscular dystrophy was studied by van der Kooi 2004. Seventy participants with facioscapulohumeral muscular dystrophy were randomly assigned either to a "training" or "non training" group. The training group underwent moderate, progressive strength training focusing on elbow flexors and ankle dorsiflexors. Training consisted mainly of dynamic exercises carried out at home three times a week for 26 weeks. Participants were evaluated every third week for muscle strength (isometric, sustained and dynamic). Muscle mass was also estimated using computerised tomography.

The treatment group showed increases in all strength parameters in comparison with the control group at the elbow but only in isometric and sustained strength at the ankle. Statistical significance was only found with respect to dynamic strength at the elbow (27% increase in training group versus 7% increase in control group). No data were provided regarding the other outcomes.

The authors concluded that mainly dynamic strength training could lead to very specific, moderate gains in dynamic strength without any negative effects.

Participants were secondarily randomised at 26 weeks into one of four groups: training or non-training with either albuterol or placebo for a subsequent 26 weeks. The final assessment took place at 52 weeks from when the initial training began. Regardless of drug status training did not improve static strength of the elbow flexors (maximum voluntary isometric strength and 30 second sustained isometric strength). However, dynamic strength did improve in comparison to the non-training group ("1-repetitive maximum"). All strength measurements for elbow flexors increased significantly in the albuterol treatment groups compared to the placebo groups. Ankle dorsiflexor strength did not appear to be improved by either training or the use of albuterol, alone or in combination and showed a decrease of 8 to 28% in all groups. The authors concluded that the use of albuterol can induce moderate strength gains in addition to the findings of the preceding study.

Myotonic dystrophy

Exercise and strength training

Strength training was also studied in participants with myotonic dystrophy by Lindeman 1995. Patients living within 100 km of Maastricht between the age of 16 and 60 years were recruited and subjected to a "qualification period" to establish their suitability for the trial, and provide them with the information necessary for them to consent. Participants were excluded based on any contraindications to muscle strengthening exercises or other unrelated disabling conditions that could influence the scoring. Thirty-three participants were individually matched on the basis of muscle strength and performance on a stair-climbing test before being randomly assigned to a training or control group. The treatment group carried out home based knee extension and flexion, and hip extension and abduction weight exercises three times a week for 24 weeks, completing a training diary over the course of the programme. Training was progressive over the course of the 24-week programme. Over the first eight weeks participants carried out three sets of 25 repetitions at 60% of one maximum repetition (1RM). From the ninth to the sixteenth week, intensity was increased to three sets of fifteen repetitions at 70 % of 1RM, and during the final eight week period, the intensity progressed further to three sets of ten repetitions at 80 % of 1RM. Outcome assessments were carried out after eight, sixteen and 24 weeks by an observer blinded to treatment allocation. Outcome measures used included isokinetic and isometric muscle strength and endurance (using a CYBEX Dynamometer), and functional performance based on stair climbing, rising from a chair or from supine, and walking 6 and 50 metres. In addition participants completed the Western Ontario & MacMaster University Osteoarthritis Index (WOMAC) and the Sickness Impact Profile (SIP). Participants also scored their difficulty in performing life activities on a Visual Analogue Scale. Finally they were asked to identify the "disease related problems they faced in daily life" using a questionnaire adapted from the "Problem Elicitation Technique" (PET).

Compliance with therapy was high and a low drop out rate was observed. With respect to physical functional abilities, there was no significant change in stair climbing, rising from a chair or from supine position, or walking six or 50 metres. Based on the WOMAC, statistically significant improvement was found in standing, getting into and out of a car and putting on socks.

Using the Problem Elicitation Technique scale, most of the hindrances reported concerned activities that participants believed were due to impaired leg function. In the treatment group, four out of fifteen participants reported they could perform more activities, whilst one reported a decrease in capacity to do so. In the control group four out of eighteen reported a decrease and only one reported an increase in the ability to perform activities. However, no statistically significant change was found.

Based on the "global assessment" the training group showed significant improvement compared with controls in the responses to the questions: "How were your complaints last week" and "I am less hindered in daily activities because of my strength reduction. Sixty-four per cent of the training group felt they had derived benefit from the intervention.

With respect to strength, there was no significant change in knee torque or endurance although a small non-significant training effect was observed in individuals in the training group who had higher baseline strength. This is thought to be due to a higher potential for strength increase in the stronger individuals. The training group also increased in strength endurance compared to

a decrease in the control group. However, these differences were non-significant.
Only one participant experienced adverse effects in the form of muscle pain and transient strength reduction. The authors suggest that as no adverse effects were observed as a result of the training, a more intense workload should be investigated in a similar population in future studies.

Peripheral neuropathy

Exercise and strength training

A muscle strengthening exercise programme was evaluated in participants with Charcot-Marie-Tooth disease (Types 1 or 2) in conjunction with the exercise programme carried out with people with myotonic dystrophy described previously (Lindeman 1995). Twenty-nine participants (21 with Charcot-Marie-Tooth disease type 1, six with type 2, and two with unknown type) were individually matched based on muscle strength and performance on a stair-climbing test. Within each matched pair, participants were randomly assigned to a training or control group. Outcome measures and the training group's intervention were identical to those outlined in the previous study.
Compliance with therapy was high and a low drop-out rate was observed.

- Six metre walk time decreased significantly in the training group compared to the control group (P = 0.01).
- With respect to functional abilities on the WOMAC, significant changes were found in stair climbing, rising from a chair, getting into and out of a car, putting on socks and lying down on the bed.
- From the Problem Elicitation Technique, in the treatment group 7 out of 15 participants could perform more activities as a result of training, whereas two reported a decrease in capacity to do so. In the control group 2 out of 13 participants reported a decrease in activities, and none reported an increase.
- No significant changes were found in the "global assessment". However, 93% of the participants felt they had derived benefit from the intervention.
- Isokinetic knee extension torque increased significantly in the training group (14%, P < 0.005) and flexion torque increased but without statistical significance (13%, P = 0.07).

Two participants experienced adverse effects in the form of muscle pain and transient strength reduction. The authors suggest that as minimal adverse effects were observed as a result of the training, a more intense workload could be investigated in a similar population in future studies.

Risk of bias in included studies

Details of the methodological quality of the included studies are described in the 'Characteristics of included studies' table, Table 2 and Table 3. All studies were rated using the van Tulder (van Tulder 1997) scale of methodological quality. Studies were included if they fulfilled the criteria specified above.

Table 2. Methodological Quality assessed by the van Tulder Method

Study ID	Internal validity	Descriptive criteria	Statistical Criteria	High Quality
Manzur 1992	5	4	2	High quality for descriptive criteria only
Lindeman 1995	8	5	1	High for internal validity & descriptive criteria
Van der Kooi 2004	9	6	2	High qulity for all criteria

Manzur 1992

Details of randomisation were not explicit stating only that participants were randomised into groups. No details of allocation concealment were provided. In addition blinding of outcome assessors was not carried out. However, withdrawal and drop-outs were described and acceptable and follow-up measures were carried out at short and long-term. Intention-to-treat analysis was also carried out.

van der Kooi 2004

In the van der Kooi 2004 study, participants were randomly assigned either to a "training" or "non-training" group and again into drug treatment groups, although no further details on the randomisation methods were provided. There was no evidence of allocation concealment. Participants and therapists were blinded to the drug treatment, as were assessors to all interventions. In addition, withdrawals and drop-outs were described and acceptable and short-term and long-term follow up measures were performed. Intention-to treat analysis was also carried out.

Lindeman 1995

In the Lindeman 1995 study, participants were individually matched into pairs on the basis of muscle strength and performance on a stair-climbing test. Within each matched pair participants were randomly assigned to a training or control group. Although treatment allocation was not concealed during randomisation, assessors were blinded to treatment allocation. This was monitored and results revealed assessors were aware of participants' group in only 20% of cases. Withdrawal and dropouts were described and acceptable and follow-up measures were performed at both short and long-term stages.

Effects of interventions

Duchenne muscular dystrophy

Primary outcome measure: Walking ability using a validated objective test

In the Manzur 1992 trial with 20 participants, at one year, "Early" surgery did not improve 28 feet or 150 feet walking times. The mean walking speeds (in seconds) increased by 0.3 and 1.3 (respectively) in the control group (n = 10) and 0.8 and 4.1 in the surgery group (n = 10). The mean difference (MD) for walking time for 28 feet was 0.00 seconds, 95% confidence interval (CI) -0.83 to 0.83 (see Analysis 01.01) and for 150 ft was -2.88, 95% CI -8.18 to 2.42 (see Analysis 01.02). At two years the data for 150ft walking speed were only available for control and surgery participants. Two boys (out of three) deteriorated rapidly in the second year post surgery. The data were not available at the 9 year follow up (Manzur 1992).

Secondary outcome measures: ankle ROM, ankle dorsiflexor strength, activity measures, participation measures, QOL, cost effectiveness and adverse effects

For the secondary measures, "early" surgery did not have a significant effect on muscle strength measured by mean kg force of 6 lower limb muscle groups. Strength decreased by 0.7 kg force in the control group and 0.7 kg force in the surgery group (MD 0.0 kg force, 95% CI -0.55 to 0.55 secs) (see Analysis 01.04). At one year after randomisation no significant difference in "motor ability score" was seen. The mean change was -1 in the control, and -2 in the surgery group, MD 1 (motor ability score 0 to 40) 95% CI -1.08 to 3.08 (see Analysis 01.03). 'No benefit' was reported at nine years. Surgery appeared to have a positive effect on contractures in the short-term, with a mean increase in control group of 3º and mean decrease of 7.5º in the surgery group. At 2 years, 5 of 6 operated boys had recurrence of contracture and all (number not given) had recurrence at 9 years (Manzur 1992).

Facioscapulohumeral muscular dystrophy

Primary outcome measure: Walking ability using a validated objective test

Data for this outcome were not available.

Secondary outcome measures: ankle ROM, ankle dorsiflexor strength, activity measures, participation measures, QOL, cost effectiveness and adverse effects

In one trial with altogether 65 participants (van der Kooi 2004), there was a decrease in strength at ankle dorsiflexion in both the training and non-training groups but without any significant difference between the two groups (isometric strength MD -0.43, 95% CI -2.48 to 1.62 KgF; dynamic strength MD 0.44, 95% CI -0.89 to 1.77 KgF, see Analyses 02.01 and 02.02). By contrast there was an increase in the strength of the other exercised muscle group, elbow flexion, which was not the topic of this review.

Myotonic dystrophy

Primary outcome measure: Walking ability using a validated objective test

In a trial with 28 participants, there was no significant change in mean walking speed over six or 50 metres following a 24-week strength training programme (Lindeman 1995). The mean increase was 0.5 and 3.5 seconds respectively in the control group and 0.3 and 2.7 seconds in the training group. Over 6 metres, the MD was 0.20 seconds, 95% CI -0.39 to 0.79 (see Analysis 03.01) and over 50 metres the MD was 0.80 seconds, 95% CI -3.69 to 5.29 (see Analysis 03.02).

Secondary outcome measures: ankle ROM, ankle dorsiflexor strength, activity measures, participation measures, QOL, cost effectiveness and adverse effects

The same study demonstrated no significant change in time taken (in seconds) for climbing stairs, descending from stairs, rising from a chair or standing from lying supine (see Analysis 03.03). There was statistically significant improvement in self report of ease of standing, getting into and out of a car and putting on socks, but the numerical results were not provided. Only one participant experienced adverse effects, which consisted of muscle pain and transient strength reduction.

Charcot-Marie-Tooth disease

Primary outcome measure: Walking ability using a validated objective test

In a trial with 26 participants, the mean six metre walking speed improved significantly following a 24-week strength training programme (Lindeman 1995). The walking time decreased by 1.0 seconds in the exercised group and 0.3 seconds in the control group, MD -0.70 seconds, 95% CI -1.17 to -0.23 (see Analysis 04.01). A significant difference was not seen in the 50 metre timed walk. The exercised group decreased by an average of 2.2 seconds

and the control group by 0.3 seconds, MD -1.9 seconds, 95% CI -4.09 to 0.29 (see Analysis 04.02).

Secondary outcome measures: ankle ROM, ankle dorsiflexor strength, activity measures, participation measures, QOL, cost effectiveness and adverse effects

The training programme led to no significant change in time taken for climbing stairs, descending from stairs, rising from a chair or standing from lying supine (see Analysis 04.03). There was a significant improvement in self reported stair climbing, rising from a chair, getting into and out of a car, putting on socks and lying down on the bed, but the numerical results were not provided. Two participants experienced adverse effects, ie muscle pain and transient strength reduction.

Subgroup analysis

Insufficient data were available to allow us to compare interventions in the common aetiological subgroups proposed in the protocol.

DISCUSSION

The review provides little evidence to support any intervention for treating foot drop in terms of improving walking or secondary outcomes. The differences in patient condition and outcome measures between studies made meta-analysis impossible and made it difficult to present firm conclusions from the review. In addition, many of the studies examined were excluded due to insufficient methodological quality which substantially reduced the body of evidence.

Duchenne muscular dystrophy

There is some evidence that early surgery intervention is not effective in people with Duchenne muscular dystrophy in terms of walking speed, muscle strength or other measures of functional 'motor ability' at one, two or nine years after surgery. Surgery appeared to have a positive effect on contractures in the short-term although no long-term advantage was observed (Manzur 1992) and the long-term risk of surgery increasing disability has not been assessed.

Facioscapulohumeral muscular dystrophy

A six-week strength training programme of the ankle flexors failed to show any increase in strength in participants with facioscapulohumeral muscular dystrophy (van der Kooi 2004). However, it was well tolerated with no reported adverse events. No measures of functionality were carried out making it impossible to draw conclusions about the effects of interventions on functional activities.

Myotonic dystrophy

A 24-week strength training programme was found to have no effect on walking speed or the time taken to complete functional tasks (Lindeman 1995). Participants reported ease of standing, getting into and out of a car and putting on socks, but numerical data are not presented.

Charcot-Marie-Tooth disease

A 24-week strength training programme was found to improve walking speed but led to no significant change in time taken (in seconds) for climbing stairs, descending from stairs, rising from a chair or standing from lying supine (Lindeman 1995). Participants reported improvement in functional tasks such as rising from a chair, getting into and out of a car, putting on socks and lying down on the bed, but no numerical results were presented.

Excluded studies

Most of the studies were excluded because of methodological inadequacies (not randomised or fatal flaws such as drop outs exceeding 40%) and/or did not use an outcome specified in the review. A non-randomised study (without masked assessment) by Forst 1999 described the long-term outcome of 213 participants with Duchenne muscular dystrophy 87 of whom had surgery. They concluded that the operation delayed the loss of independent ambulation by 1.25 years, and change in strength did not differ between groups. However, the baseline characteristics of the two groups were not reported. In a randomised study of 27 boys with Duchenne muscular dystrophy Hyde 2000 investigated the effects of wearing night splints on contractures and concluded that the treatment group had a statistically significant annual delay of 23% in the development of contractures compared to the control group. However, the study was categorised as fatally flawed because the number of drop-outs was excessive (9 of 15, 60% in the intervention group). The effect of an ankle-foot orthosis on the strength of paretic dorsiflexors was investigated in a non-randomised study of 26 people with foot drop secondary to peroneal neuropathy or L5 radiculopathy of six weeks to twelve months duration by Geboers 2001a. The authors concluded that ankle-foot-orthosis did not influence the restoration of strength in participants with recent peripheral paralysis, but did not adversely influence recovery. Additionally, the authors stated that the decrease in strength observed in the healthy side of participants may be attributable to an overall loss of strength due to a decrease in activity.

The review covered a broad population of participants of all ages. All studies involving participants described as having lower motor neuron or floppy foot drop and contractures of tendons that develop secondary to foot drop affecting ankle range of motion were included in the review. The wide range of patient characteristics, incomparable outcome measures and poor methodological quality made it difficult to carry out any meta-analysis which in turn made it difficult to draw hard conclusions from the review. Exercise intervention is well tolerated and without adverse effect and may have a positive effect particularly in those with Charcot-Marie-Tooth disease. However strong evidence is lacking and further studies to support these findings would be beneficial. Early surgery was also shown to have few benefits for children with Duchenne muscular dystrophy and the long term risks have not been assessed.

Limitations of this review

This review is subject to various limitations. First, our search may have missed some relevant studies. The terms we used to identify the groups of participants studied are imprecise, and it is possible that studies may have been undertaken and reported using other terms or simply giving the underlying disease (e.g. poliomyelitis) on the grounds that there would be no clinical need to specify that there was a floppy foot drop. However searching for studies on the treatment (e.g. orthoses) would have identified many studies investigating foot drop due to upper motor neuron lesions, or joint pathology.

Second, the review was based on the assumption that rehabilitation treatments for foot-drop where there was reduced muscle strength and no increase in muscle tone could be considered as being similar in their effects and side-effects. However this may not be the case. For example it is possible that muscle strengthening exercises could be beneficial in people with disease of the lower motor neurone but harmful in people with disease of the muscle itself. In fact the evidence would suggest that this is not the case, but there may be other examples where there is a differential effect.

Third, the choice of primary outcome measure (quantitative measures of walking performance) was based on the assumption that walking speed would correlate with performance in most other activities involving mobility. The results in at least one of the studies suggests that this may not be true, and that it may not be sensible in future to focus on walking speed. The alternative is to ask about a range of specific activities that depend upon aspects of mobility, investigating which activities are helped by any specific treatment.

AUTHORS' CONCLUSIONS

Implications for practice

Evidence from one trial suggests that exercise is not detrimental and may benefit the ability to walk in Charcot-Marie-Tooth disease. Limited evidence from one randomised trial showed no significant benefit from early surgery to lengthen the Achilles tendon in Duchenne muscular dystrophy on walking ability after one, two or nine years. There have been no randomised trials to investigate the efficacy of ankle foot orthoses for foot drop. Future studies and future versions of this review should include outcome measures which assess function such as measures of activities of daily living and gait.

Implications for research

Exercise regimens of varying intensity and frequency have provided some evidence of benefit and should be evaluated in more detail in the future. The use of orthotics on function and physiological cost would be worthy of investigation. In addition the cost effectiveness of such interventions should be investigated. Future studies should include outcome measures which assess function such as measures of activities of daily living. This would allow readers to assess the influence of interventions on everyday life and not concentrate purely on factors such as strength and range of motion. It is important to link changes in strength and range of motion with actual functionality.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of Prof Richard Hughes and Kate Jewitt of the Cochrane Neuromuscular Disease Group, Angela Gunn of the Radcliffe Library, Oxford for assistance with the literature searches, Tom Hoppitt for assistance with reviewing the studies and earlier drafts and Kathie Vezzoso of the Rehab Programme, University of Melbourne for administrative assistance.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Lindeman 1995

Methods	RCT of matched pairs (matching on muscle strength)
Participants	Participants with myotonic dystrophy or Charcot-Marie-Tooth disease (CMT).
Interventions	Exercise (n = 14 MyD and n = 13 CMT) versus no exercise (n = 14 MyD and n = 13 CMT).
Outcomes	Muscle strength and endurance, walking, stairs, WOMAC, SIP, VAS (life activities).
Notes	Statistical change only in walking in CMT: trends to positive effect in all parameters.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Manzur 1992

Methods	Unblinded RCT
Participants	Boys aged 4 to 6 years with Duchenne muscular dystrophy.
Interventions	Surgical (n = 10) versus conservative treatment (n = 10).
Outcomes	Muscle strength, walking, Gower's time, contracture measurement, motor activities.
Notes	No difference in outcome at 1 year. Follow up study in 1999, No difference in outcome at 8 to 11 yrs.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

van der Kooi 2004

Methods	Unblinded RCT (two stage)
Participants	Participants with facioscapulohumeral muscular dystrophy.
Interventions	Strength training (n = 34) versus no training (n = 31): second randomisation at 26/52 into albuterol vs no drug treatment.
Outcomes	Muscle strength in legs and arms and muscle mass at 6 weeks. Muscle strength in legs and arms at 1 year.
Notes	At 6 weeks, training led to increased strength: statistically significant only at elbow. At 1 year, training led to increased dynamic of elbow; albuterol increased elbow flexion: ankle dorsiflexion deteriorated . Published abstracts of both parts of the study van der Kooi 2000 and van der Kooi 2001.

Risk of bias

Item	**Authors' judgement**	**Description**
Allocation concealment?	No	C - Inadequate

RCT - randomised controlled trial
MyD - myotonic dystrophy
WOMAC - Western Ontario and McMaster University Osteoarthritis Index
SIP - Sickness Impact Profile
VAS - Visual analogue scale

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

Forst 1995	Not randomised, compared with 'natural history' cohort.
Forst 1999	Not randomised, compared with 'natural history' cohort.
Geboers 2001a	Not randomised, if alternative allocation on enrolment was used there would not be a 4 person difference between groups at entry (11,15). Assessment not masked. No allocation concealment. Large between group difference in mean age at entry (42 versus 60 years).
Geboers 2001b	Same as Geboers 2001a and Geboers2002.
Geboers 2002	Same study as 2001a, compliance not reported for follow up data.

(*Continued*)

Hyde 2000	Drop out rate, 9 of 15 in intervention, 7 of 12 in 'control', total 16 of 27.
Richardson 2001	Did not use the specified outcome measures. Foot drop not diagnosed, paper talks about 'subclinical motor involvement'.
Wiesinger 1998	Not foot drop

DATA AND ANALYSES

Comparison 1. Early surgery vs control in Duchenne Muscular Dystrophy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Change in 28ft walking speed in seconds	1	20	Mean Difference (IV, Fixed, 95% CI)	Not estimable
2 Change in 150ft walking speed in seconds	1	20	Mean Difference (IV, Fixed, 95% CI)	-2.88 [-8.18, 2.42]
3 Change in motor ability score (min 0 max 40)	1	20	Mean Difference (IV, Fixed, 95% CI)	1.0 [-1.08, 3.08]
4 Change in combined strength of 6 lower limb muscle groups in kilogram force	1	20	Mean Difference (IV, Fixed, 95% CI)	Not estimable

Comparison 2. Strength training versus control in FSHD

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Change in muscle strength of ankle dorsiflexors - maximum voluntary isometric contraction in kilogram force	1	65	Mean Difference (IV, Fixed, 95% CI)	-0.43 [-2.48, 1.62]
2 Change in muscle strength ankle dorsiflexors - dynamic strength in kilograms	1	65	Mean Difference (IV, Fixed, 95% CI)	0.44 [-0.89, 1.77]

Comparison 3. Strength training vs control in Myotonic Dystrophy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Decrease in time to walk 6m comfortably in seconds	1	28	Mean Difference (IV, Fixed, 95% CI)	0.20 [-0.39, 0.79]
2 Decrease in time to walk 50m, fast in seconds	1	28	Mean Difference (IV, Fixed, 95% CI)	0.80 [-3.69, 5.29]
3 Change in time spent to achieve mobility activities in seconds	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 Descending stairs	1	28	Mean Difference (IV, Fixed, 95% CI)	-2.0 [-6.22, 2.22]
3.2 Climbing stairs	1	28	Mean Difference (IV, Fixed, 95% CI)	-0.8 [-3.98, 2.38]
3.3 Standing up from a chair	1	28	Mean Difference (IV, Fixed, 95% CI)	-1.0 [-3.14, 1.14]

3.4 Standing up from lying supine	1	28	Mean Difference (IV, Fixed, 95% CI)	0.9 [-0.47, 2.27]

Comparison 4. Strength training vs control in Charcot-Marie-Tooth disease

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Decrease in time to walk 6m comfortably (seconds)	1	26	Mean Difference (IV, Fixed, 95% CI)	-0.7 [-1.17, -0.23]
2 Decrease in time to walk 50m fast walk (seconds)	1	26	Mean Difference (IV, Fixed, 95% CI)	-1.90 [-4.09, 0.29]
3 Change in time spent to achieve mobility activities (seconds)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 Descending stairs	1	26	Mean Difference (IV, Fixed, 95% CI)	-0.79 [-1.95, 0.37]
3.2 Climbing stairs	1	26	Mean Difference (IV, Fixed, 95% CI)	-0.71 [-1.71, 0.29]
3.3 Standing up from a chair (seconds)	1	26	Mean Difference (IV, Fixed, 95% CI)	-0.15 [-0.47, 0.17]
3.4 standing up from lying supine (seconds)	1	26	Mean Difference (IV, Fixed, 95% CI)	-0.2 [-0.62, 0.22]

Analysis 1.1. Comparison 1 Early surgery vs control in Duchenne Muscular Dystrophy, Outcome 1 Change in 28ft walking speed in seconds.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 1 Early surgery vs control in Duchenne Muscular Dystrophy

Outcome: 1 Change in 28ft walking speed in seconds

Study or subgroup	control N	Mean(SD)	treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Manzur 1992	10	-0.1 (0.95)	10	-0.1 (0.95)		100.0 %	0.0 [-0.83, 0.83]
Total (95% CI)	**10**		**10**			**100.0 %**	**0.0 [-0.83, 0.83]**

Heterogeneity: not applicable

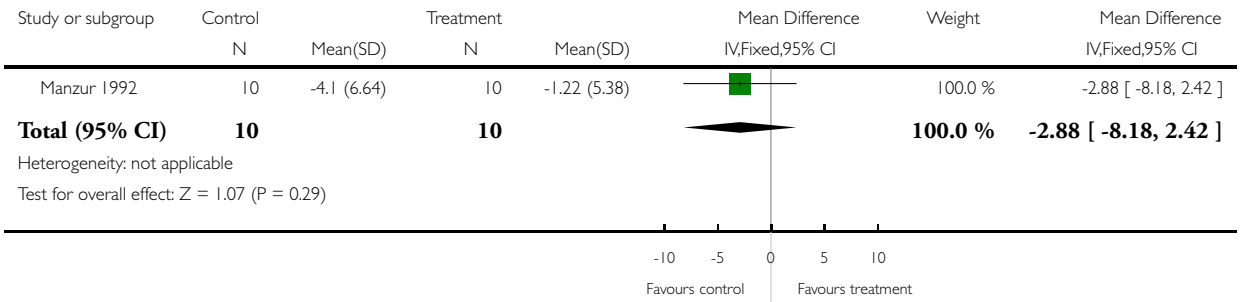
Test for overall effect: Z = 0.0 (P = 1.0)

Analysis 1.2. Comparison 1 Early surgery vs control in Duchenne Muscular Dystrophy, Outcome 2 Change in 150ft walking speed in seconds.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 1 Early surgery vs control in Duchenne Muscular Dystrophy

Outcome: 2 Change in 150ft walking speed in seconds

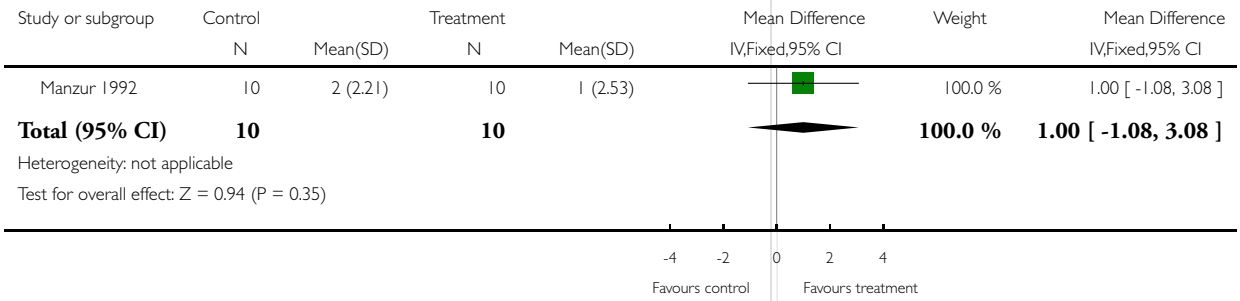


Analysis 1.3. Comparison 1 Early surgery vs control in Duchenne Muscular Dystrophy, Outcome 3 Change in motor ability score (min 0 max 40).

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 1 Early surgery vs control in Duchenne Muscular Dystrophy

Outcome: 3 Change in motor ability score (min 0 max 40)



Analysis 1.4. Comparison 1 Early surgery vs control in Duchenne Muscular Dystrophy, Outcome 4 Change in combined strength of 6 lower limb muscle groups in kilogram force.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 1 Early surgery vs control in Duchenne Muscular Dystrophy

Outcome: 4 Change in combined strength of 6 lower limb muscle groups in kilogram force

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Manzur 1992	10	0.7 (0.63)	10	0.7 (0.63)		100.0 %	0.0 [-0.55, 0.55]
Total (95% CI)	**10**		**10**			**100.0 %**	**0.0 [-0.55, 0.55]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P = 1.0)

Analysis 2.1. Comparison 2 Strength training versus control in FSHD, Outcome 1 Change in muscle strength of ankle dorsiflexors - maximum voluntary isometric contraction in kilogram force.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

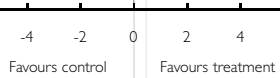
Comparison: 2 Strength training versus control in FSHD

Outcome: 1 Change in muscle strength of ankle dorsiflexors - maximum voluntary isometric contraction in kilogram force

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
van der Kooi 2004	31	-1.56 (4.16)	34	-1.13 (4.28)		100.0 %	-0.43 [-2.48, 1.62]
Total (95% CI)	**31**		**34**			**100.0 %**	**-0.43 [-2.48, 1.62]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.41 (P = 0.68)



Analysis 2.2. Comparison 2 Strength training versus control in FSHD, Outcome 2 Change in muscle strength ankle dorsiflexors - dynamic strength in kilograms.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 2 Strength training versus control in FSHD

Outcome: 2 Change in muscle strength ankle dorsiflexors - dynamic strength in kilograms

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
van der Kooi 2004	31	-1.06 (2.78)	34	-1.5 (2.68)		100.0 %	0.44 [-0.89, 1.77]
Total (95% CI)	**31**		**34**			**100.0 %**	**0.44 [-0.89, 1.77]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.65 (P = 0.52)

Analysis 3.1. Comparison 3 Strength training vs control in Myotonic Dystrophy, Outcome 1 Decrease in time to walk 6m comfortably in seconds.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

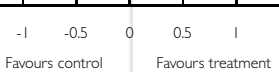
Comparison: 3 Strength training vs control in Myotonic Dystrophy

Outcome: 1 Decrease in time to walk 6m comfortably in seconds

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Lindeman 1995	14	0.5 (0.8)	14	0.3 (0.8)		100.0 %	0.20 [-0.39, 0.79]
Total (95% CI)	**14**		**14**			**100.0 %**	**0.20 [-0.39, 0.79]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.66 (P = 0.51)



Analysis 3.2. Comparison 3 Strength training vs control in Myotonic Dystrophy, Outcome 2 Decrease in time to walk 50m, fast in seconds.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 3 Strength training vs control in Myotonic Dystrophy

Outcome: 2 Decrease in time to walk 50m, fast in seconds

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Lindeman 1995	14	3.5 (5.8)	14	2.7 (6.3)		100.0 %	0.80 [-3.69, 5.29]
Total (95% CI)	**14**		**14**			**100.0 %**	**0.80 [-3.69, 5.29]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.35 (P = 0.73)							

Analysis 3.3. Comparison 3 Strength training vs control in Myotonic Dystrophy, Outcome 3 Change in time spent to achieve mobility activities in seconds.

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 3 Strength training vs control in Myotonic Dystrophy

Outcome: 3 Change in time spent to achieve mobility activities in seconds

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Descending stairs							
Lindeman 1995	14	0.5 (3.6)	14	2.5 (7.2)		100.0 %	-2.00 [-6.22, 2.22]
Subtotal (95% CI)	**14**		**14**			**100.0 %**	**-2.00 [-6.22, 2.22]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.93 (P = 0.35)							
2 Climbing stairs							
Lindeman 1995	14	0.3 (1.8)	14	1.1 (5.8)		100.0 %	-0.80 [-3.98, 2.38]
Subtotal (95% CI)	**14**		**14**			**100.0 %**	**-0.80 [-3.98, 2.38]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.49 (P = 0.62)							
3 Standing up from a chair							
Lindeman 1995	14	0.2 (0.8)	14	1.2 (4)		100.0 %	-1.00 [-3.14, 1.14]
Subtotal (95% CI)	**14**		**14**			**100.0 %**	**-1.00 [-3.14, 1.14]**

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Heterogeneity: not applicable							
Test for overall effect: Z = 0.92 (P = 0.36)							
4 Standing up from lying supine							
Lindeman 1995	14	0.5 (2.2)	14	-0.4 (1.4)		100.0 %	0.90 [-0.47, 2.27]
Subtotal (95% CI)	**14**		**14**			**100.0 %**	**0.90 [-0.47, 2.27]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.29 (P = 0.20)							
Test for subgroup differences: Chi² = 3.59, df = 3 (P = 0.31), I² =17%							

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 3 Strength training vs control in Myotonic Dystrophy

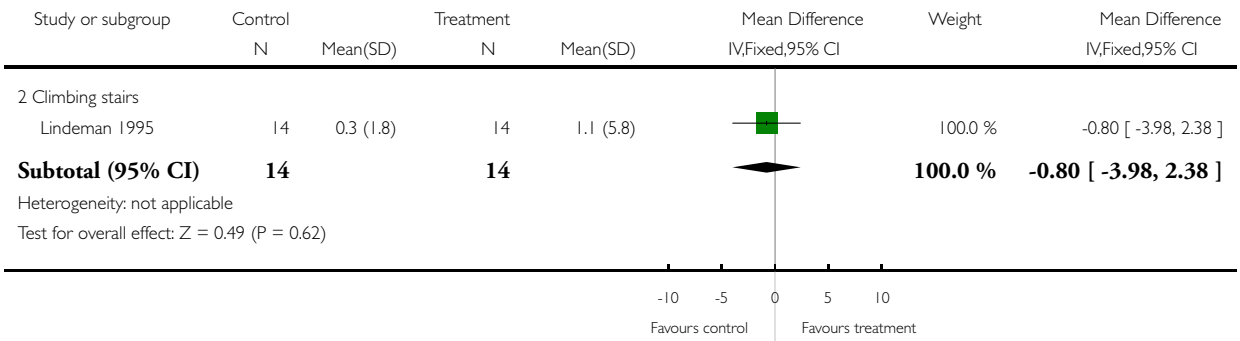
Outcome: 3 Change in time spent to achieve mobility activities in seconds

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Descending stairs							
Lindeman 1995	14	0.5 (3.6)	14	2.5 (7.2)		100.0 %	-2.00 [-6.22, 2.22]
Subtotal (95% CI)	**14**		**14**			**100.0 %**	**-2.00 [-6.22, 2.22]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.93 (P = 0.35)							

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 3 Strength training vs control in Myotonic Dystrophy

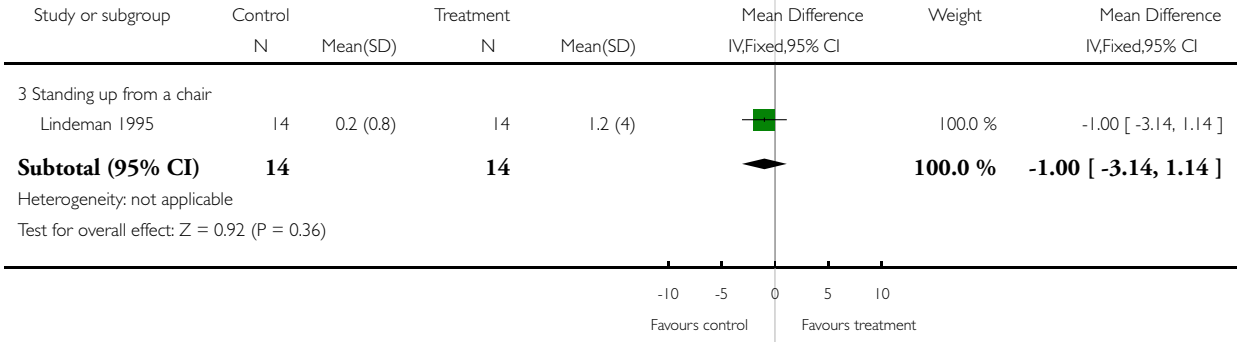
Outcome: 3 Change in time spent to achieve mobility activities in seconds



Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 3 Strength training vs control in Myotonic Dystrophy

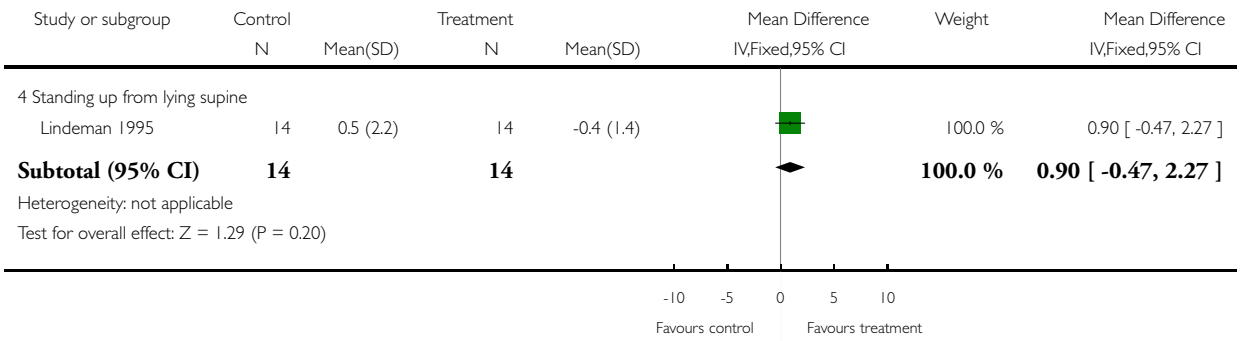
Outcome: 3 Change in time spent to achieve mobility activities in seconds



Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 3 Strength training vs control in Myotonic Dystrophy

Outcome: 3 Change in time spent to achieve mobility activities in seconds



Analysis 4.1. Comparison 4 Strength training vs control in Charcot-Marie-Tooth disease, Outcome 1 Decrease in time to walk 6m comfortably (seconds).

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

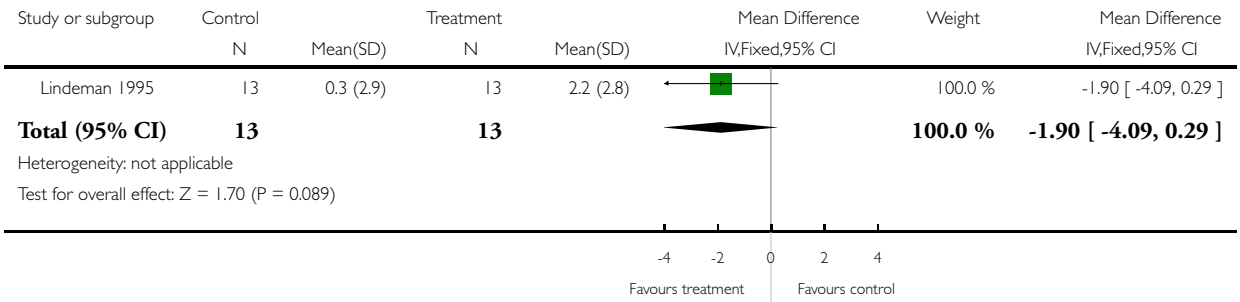
Outcome: 1 Decrease in time to walk 6m comfortably (seconds)

Analysis 4.2. Comparison 4 Strength training vs control in Charcot-Marie-Tooth disease, Outcome 2 Decrease in time to walk 50m fast walk (seconds).

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

Outcome: 2 Decrease in time to walk 50m fast walk (seconds)

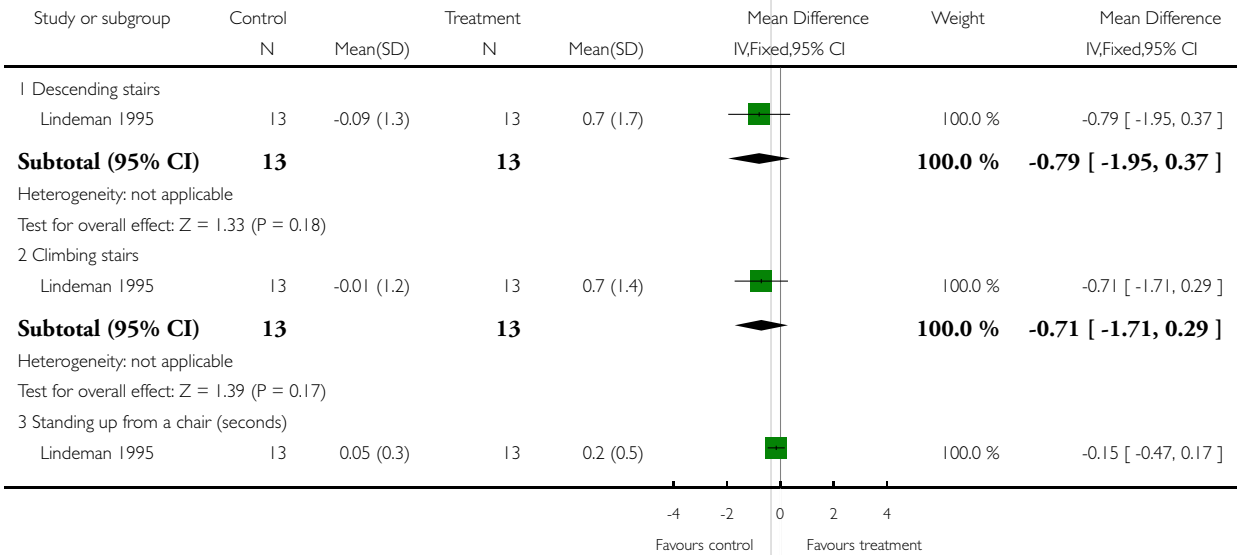


Analysis 4.3. Comparison 4 Strength training vs control in Charcot-Marie-Tooth disease, Outcome 3 Change in time spent to achieve mobility activities (seconds).

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

Outcome: 3 Change in time spent to achieve mobility activities (seconds)



(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
Subtotal (95% CI)	**13**		**13**			**100.0 %**	**-0.15 [-0.47, 0.17]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.93 (P = 0.35)							
4 standing up from lying supine (seconds)							
Lindeman 1995	13	0.1 (0.5)	13	0.3 (0.6)		100.0 %	-0.20 [-0.62, 0.22]
Subtotal (95% CI)	**13**		**13**			**100.0 %**	**-0.20 [-0.62, 0.22]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.92 (P = 0.36)							
Test for subgroup differences: Chi^2 = 2.03, df = 3 (P = 0.57), I^2 =0.0%							

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

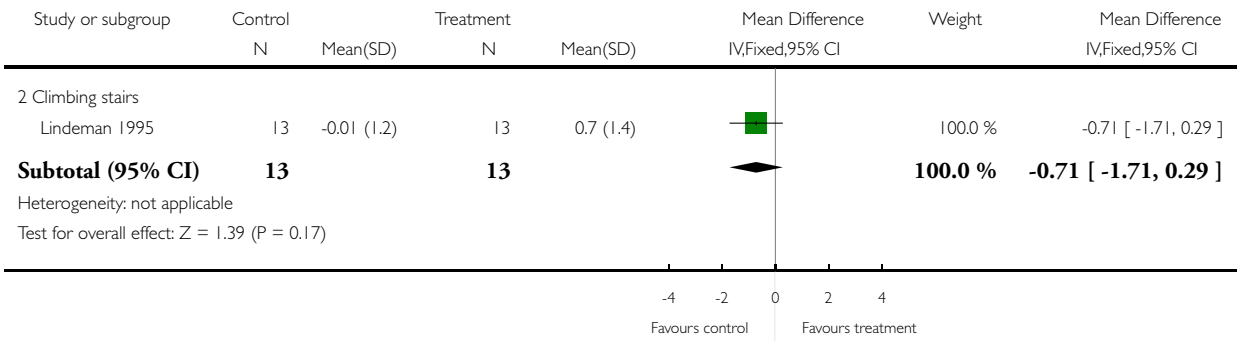
Outcome: 3 Change in time spent to achieve mobility activities (seconds)

Study or subgroup	Control N	Mean(SD)	Treatment N	Mean(SD)	Mean Difference IV,Fixed,95% CI	Weight	Mean Difference IV,Fixed,95% CI
1 Descending stairs							
Lindeman 1995	13	-0.09 (1.3)	13	0.7 (1.7)		100.0 %	-0.79 [-1.95, 0.37]
Subtotal (95% CI)	**13**		**13**			**100.0 %**	**-0.79 [-1.95, 0.37]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.33 (P = 0.18)							

Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

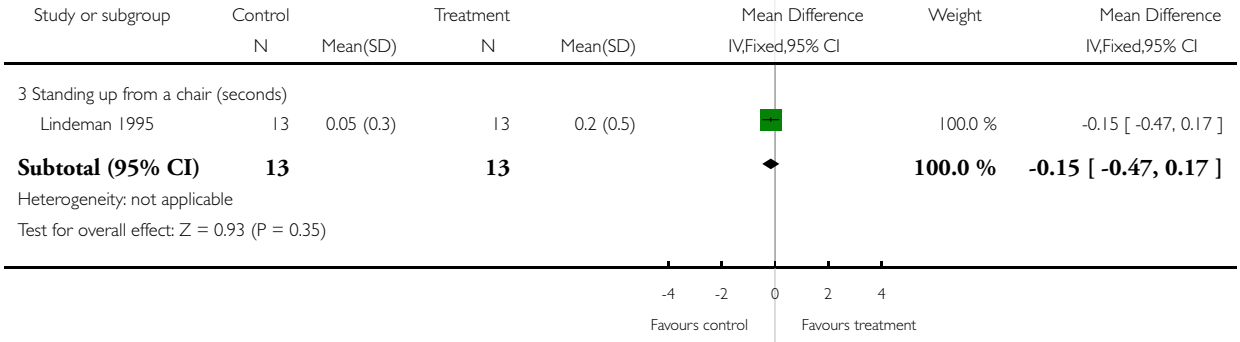
Outcome: 3 Change in time spent to achieve mobility activities (seconds)



Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

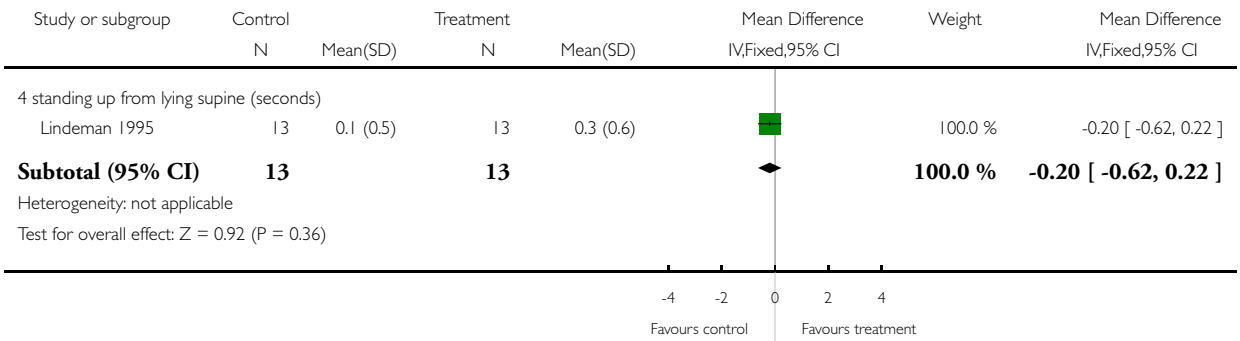
Outcome: 3 Change in time spent to achieve mobility activities (seconds)



Review: Rehabilitation interventions for foot drop in neuromuscular disease

Comparison: 4 Strength training vs control in Charcot-Marie-Tooth disease

Outcome: 3 Change in time spent to achieve mobility activities (seconds)



APPENDICES

Appendix 1. OVID MEDLINE search strategy

1. ((foot adj1 drop$3) or floppy foot).mp. or drop foot/
2. exp gait disorders, neurologic/
3. (lower or leg or foot or ankle or achilles or tendon or peroneal nerve).mp
4. leg/ or foot/ or ankle/ or achilles tendon/ or tendon injuries/ or peroneal nerve/ or ankle injuries/ or foot injuries/ or foot deformities, acquired/
5. ((lower adj2 motor neuron$2) or motorneuron$2).mp
6. contracture$.mp
7. Contracture/
8. dorsiflex$.mp
9. neuromuscular$ disease$.mp]
10. exp Neuromuscular Diseases/
11. nerve compression syndromes/
12. nerve compression syndromes.mp
13. exp peripheral nervous system diseases/
14. peripheral$ nervous$ system$ disease$.mp
15. rehabilitation$.mp
16. activities of daily living.mp
17. exercise/
18. exercise.mp
19. (physical therap$ or physiotherap$ or physical stimulation$).mp
20. SURGERY/ or surgery.mp
21. ORTHOTIC DEVICES/
22. orthotic$.mp
23. orthos$.mp
24. Splints/
25. splint$.mp
26. exp REHABILITATION/

27. or/9-14
28. or/15-25
29. 3 or 4
30. 6 or 7 or 8
31. 29 and 30
32. 1 or 2 or 5 or 31
33. 27 and 32
34. 28 and 33
35. randomized controlled trial.pt.
36. randomized controlled trials/
37. controlled clinical trial.pt.
38. controlled clinical trials/
39. random allocation/
40. double-blind method/
41. single-blind method/
42. clinical trial.pt.
43. exp clinical trials/
44. (clin$ adj25 trial$).tw.
45. ((singl$ or doubl$ or tripl$ or trebl$) adj25 (blind$ or mask$ or dummy)).tw.
46. placebos/
47. placebo$.tw.
48. random$.tw.
49. research design/
50. (clinical trial phase i or clinical trial phase ii or clinical trial phase iii or clinical trial phase iv).pt.
51. multicenter study.pt.
52. meta analysis.pt.
53. Prospective Studies/
54. Intervention Studies/
55. Cross-Over Studies/
56. Meta-Analysis/
57. (meta?analys$ or systematic review$).tw.
58. control.tw.
59. or/35-58
60. Animal/
61. Human/
62. 60 and 61
63. 60 not 62
64. 59 not 63
65. 34 and 64

Appendix 2. OVID EMBASE search strategy

1. ((foot adj1 drop$3) or floppy foot).tw. or peroneus nerve paralysis/
2. exp locomotion/ or gait disorders/
3. (lower or leg or foot or ankle or achilles or tendon or peroneal nerve).tw.
4. leg/ or foot/ or ankle/ or achilles tendon/ or tendon injury/ or peroneus nerve/ or ankle injury/ or foot injury/ or foot malformation/
5. ((lower adj2 motor neuron$2) or motorneuron$2).tw.
6. contracture$.tw.
7. Contracture/
8. dorsiflex$.tw.
9. neuromuscular$ disease$.tw.
10. exp Neuromuscular Diseases/

11. nerve compression/
12. nerve compression syndromes.tw.
13. exp peripheral neuropathy/
14. peripheral$ nervous$ system$ disease$.tw.
15. rehabilitation$.tw.
16. activities of daily living.tw.
17. exercise/
18. exercise.tw.
19. (physical therap$ or physiotherap$ or physical stimulation$).tw.
20. SURGERY/ or surgery.tw.
21. ORTHOTICS/
22. orthotic$.tw.
23. orthos$.tw.
24. Splint/
25. splint$.tw.
26. exp REHABILITATION/
27. or/9-14
28. or/15-25
29. 3 or 4
30. 6 or 7 or 8
31. 29 and 30
32. 1 or 2 or 5 or 31
33. 27 and 32
34. 28 and 33
35. Randomized Controlled Trial/
36. Clinical Trial/
37. Multicenter Study/
38. Controlled Study/
39. Crossover Procedure/
40. Double Blind Procedure/
41. Single Blind Procedure/
42. exp RANDOMIZATION/
43. Major Clinical Study/
44. PLACEBO/
45. Meta Analysis/
46. phase 2 clinical trial/ or phase 3 clinical trial/ or phase 4 clinical trial/
47. (clin$ adj25 trial$).tw.
48. ((singl$ or doubl$ or tripl$ or trebl$) adj25 (blind$ or mask$)).tw.
49. placebo$.tw.
50. random$.tw.
51. control$.tw.
52. (meta?analys$ or systematic review$).tw.
53. (cross?over or factorial or sham? or dummy).tw.
54. ABAB design$.tw.
55. or/35-54
56. human/
57. nonhuman/
58. 56 or 57
59. 55 not 58
60. 55 and 56
61. 59 or 60
62. 34 and 61

Appendix 3. OVID CINAHL search strategy

1. ((foot adj1 drop$3) or floppy foot).mp
2. exp locomotion/
3. (lower or leg or foot or ankle or achilles or tendon or peroneal nerve).mp
4. leg/ or foot/ or ankle/ or achilles tendon/ or tendon injury/ or peroneus nerve/ or ankle injury/ or foot injury/ or foot malformation/
5. ((lower adj2 motor neuron$2) or motorneuron$2).mp. [mp=title, subject heading word, abstract, instrumentation]
6. contracture$.mp
7. Contracture/
8. dorsiflex$.mp
9. neuromuscular$ disease$.mp
10. exp Neuromuscular Diseases/
11. nerve compression syndromes/
12. nerve compression syndromes.mp
13. exp peripheral nervous system diseases/
14. peripheral$ nervous$ system$ disease$.mp
15. rehabilitation$.mp.
16. activities of daily living.mp
17. exercise/
18. exercise.mp
19. (physical therap$ or physiotherap$ or physical stimulation$).tw.
20. surgery, operative/ or surgery.mp
21. exp orthoses/
22. orthotic$.mp
23. orthos$.mp
24. Splints/
25. splint$.mp
26. exp REHABILITATION/
27. or/9-14
28. or/15-25
29. 3 or 4
30. 6 or 7 or 8
31. 29 and 30
32. 1 or 2 or 5 or 31
33. 27 and 32
34. 28 and 33
35. random assignment/ or random sample/ or simple random sample/ or stratified random sample/ or systematic random sample/
36. Crossover design/
37. exp Clinical trials/
38. Double-blind studies/ or triple blind studies/
39. Placebos/
40. Quasi-experimental studies/
41. Solomon four-group design/ or Static group comparison/
42. Meta analysis/
43. Concurrent prospective studies/ or Prospective studies/
44. Factorial design/
45. (”clinical trial“ or ”systematic review“).pt.
46. random$.tw.
47. ((Single$ or doubl$ or tripl$ or trebl$) adj25 (blind$ or mask$)).tw.
48. (cross?over or placebo$ or control$ or factorial or sham? or dummy).tw.
49. ((clin$ or intervention$ or compar$ or experiment$ or preventive or therapeutic) adj10 trial$).tw.
50. ABAB design$.tw.
51. (meta?analys$ or systematic review$).tw.

52. or/35-51
53. 52 and 34

Appendix 4. OVID AMED search strategy

1. ((foot adj1 drop$3) or floppy foot).mp. [mp=abstract, heading words, title]
2. gait/ or locomotion/ or movement/
3. (lower or leg or foot or ankle or achilles or tendon or peroneal nerve).mp. [mp=abstract, heading words, title]
4. leg/ or foot/ or ankle/ or achilles tendon/ or tendon injuries/ or peroneal nerve/ or ankle injuries/ or foot injuries/ or foot deformities, acquired/
5. ((lower adj2 motor neuron$2) or motorneuron$2).mp. [mp=abstract, heading words, title]
6. contracture$.mp. [mp=abstract, heading words, title]
7. Contracture/
8. dorsiflex$.mp. [mp=abstract, heading words, title]
9. neuromuscular$ disease$.mp. [mp=abstract, heading words, title]
10. exp Neuromuscular Disease/
11. nerve compression syndromes/
12. nerve compression syndromes.mp. [mp=abstract, heading words, title]
13. exp peripheral nervous system disease/
14. peripheral$ nervous$ system$ disease$.mp. [mp=abstract, heading words, title]
15. rehabilitation$.mp. [mp=abstract, heading words, title]
16. activities of daily living.mp. [mp=abstract, heading words, title]
17. exercise/
18. exercise.mp. [mp=abstract, heading words, title]
19. (physical therap$ or physiotherap$ or physical stimulation$).mp. [mp=abstract, heading words, title]
20. SURGERY/ or surgery.mp. [mp=abstract, heading words, title]
21. ORTHOTIC DEVICES/
22. orthotic$.mp. [mp=abstract, heading words, title]
23. orthos$.mp. [mp=abstract, heading words, title]
24. Splints/
25. splint$.mp. [mp=abstract, heading words, title]
26. exp REHABILITATION/
27. or/9-14
28. or/15-25
29. 3 or 4
30. 6 or 7 or 8
31. 29 and 30
32. 1 or 2 or 5 or 31
33. 27 and 32
34. 28 and 33
35. Randomized controlled trials/
36. Random allocation/
37. Double blind method/
38. Single-Blind Method/
39. exp Clinical Trials/
40. (clin$ adj25 trial$).tw.
41. ((singl$ or doubl$ or treb$ or trip$) adj25 (blind$ or mask$ or dummy)).tw.
42. placebos/
43. placebo$.tw.
44. random$.tw.
45. research design/
46. Prospective Studies/

47. cross over studies/
48. meta analysis/
49. (meta?analys$ or systematic review$).tw.
50. control$.tw.
51. (multicenter or multicentre).tw.
52. ((study or studies or design$) adj25 (factorial or prospective or intervention or crossover or cross-over or quasi-experiment$)).tw.
53. or/35-52
54. 34 and 53

Appendix 5. BNI search strategy

1. ((foot adj1 drop$3) or floppy foot).mp
2. mobility/
3. (lower or leg or foot or ankle or achilles or tendon or peroneal nerve).mp
4. exp foot care/ and disorders/
5. ((lower adj2 motor neuron$2) or motorneuron$2).mp
6. contracture$.mp
7. Contracture/
8. dorsiflex$.mp
9. neuromuscular$ disease$.mp
10. exp Neuromuscular system/ and disorders/
11. nerve compression syndromes/
12. nerve compression syndromes.mp
13. exp peripheral nervous system diseases/
14. peripheral$ nervous$ system$ disease$.mp.
15. rehabilitation$.mp
16. activities of daily living.mp
17. physical fitness/
18. exercise.mp
19. (physical therap$ or physiotherap$ or physical stimulation$).tw.
20. surgery, operative/ or surgery.mp
21. orthopaedic devices/
22. orthotic$.mp
23. orthos$.mp
24. splint$.mp
25. exp REHABILITATION/
26. or/9-14
27. or/15-25
28. 3 or 4
29. 6 or 8
30. 28 and 29
31. 1 or 2 or 5 or 30
32. 26 and 31

WHAT'S NEW

Last assessed as up-to-date: 4 February 2007.

13 October 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 4, 2002

Review first published: Issue 2, 2007

5 February 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

Tom Hoppitt assisted with the quality scoring and data extraction. Peter Disler wrote the first draft of the review. Following comments from Derick Wade and Lynne Turner Stokes, Tom Hoppitt and Cath Sackley wrote the next draft. All four authors agreed on the final text.

DECLARATIONS OF INTEREST

All authors work in rehabilitation services that ultimately gain income from being referred participants who may have, inter alia, foot drop.

SOURCES OF SUPPORT

Internal sources

- Department of Medicine, University of Melbourne, Australia.
- Melbourne Health, Australia.

External sources

- Department of Health Research Capacity Development Programme, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

Charcot-Marie-Tooth Disease [complications]; Exercise Therapy [methods]; Gait Disorders, Neurologic [etiology; *rehabilitation; surgery]; Muscular Dystrophy, Duchenne [complications]; Treatment Outcome; Walking

MeSH check words

Child; Humans; Male