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Research

Stretch for the treatment and prevention of contracture: an abridged republication of a Cochrane Systematic Review ☆

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KEY WORDS

Stretch
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Contracture
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CrossMark

ABSTRACT

Question: Is stretch effective for the treatment and prevention of contractures in people with neurological and non-neurological conditions? **Design**: A Cochrane Systematic Review with meta-analyses of randomised trials. **Participants**: People with or at risk of contractures. **Intervention**: Trials were considered for inclusion if they compared stretch to no stretch, or stretch plus co-intervention to co-intervention only. The stretch could be administered in any way. **Outcome measures**: The outcome of interest was joint mobility. Two sets of meta-analyses were conducted with a random-effects model: one for people with neurological conditions and the other for people with non-neurological conditions. The quality of evidence supporting the results of the two sets of meta-analyses was assessed using GRADE. **Results**: Eighteen studies involving 549 participants examined the effectiveness of stretch in people with neurological conditions, and provided useable data. The pooled mean difference was 2 deg (95% CI 0 to 3) favouring stretch. This was equivalent to a relative change of 2% (95% CI 0 to 3). Eighteen studies involving 865 participants examined the effectiveness of stretch in people with non-neurological conditions, and provided useable data. The pooled standardised mean difference was 0.2 SD (95% CI 0 to 0.3) favouring stretch. This translated to an absolute mean increase of 1 deg (95% CI 0 to 2) and a relative change of 1% (95% CI 0 to 2). The GRADE level of evidence was high for both sets of meta-analyses. **Conclusion**: Stretch does not have clinically important effects on joint mobility. **[Harvey LA, Katalinic OM, Herbert RD, Moseley AM, Lannin NA, Schurr K (2017) Stretch for the treatment and prevention of contracture: an abridged republication of a Cochrane Systematic Review. *Journal of Physiotherapy* 63: 67–75]**

Introduction

Contractures are common for people with many types of injuries and disabilities. For example, they are common in people with neurological conditions such as brain injury, stroke or spinal cord injuries.[1,2] They are also common in people with non-neurological conditions such as burns, fractures, shoulder capsulitis and Dupuytren's disease.[3] Contractures are undesirable because they are unsightly and have deleterious effects on function and quality of life. For instance, ankle plantarflexion contractures in people with brain injuries impede gait, and finger flexion contractures in people with crush injuries interfere with hand function.

Stretch is the main intervention used by physiotherapists for the treatment and prevention of contractures. Stretch is applied in many different ways, including plaster casts, splints or through the hands of therapists (see www.physiotherapyexercises.com for examples of stretches typically prescribed by physiotherapists). In addition, physiotherapists widely recommend that people with all types of injuries and disabilities routinely stretch at home in an effort to either treat or prevent contractures. For example, those with spinal cord injuries are often instructed to devote up to 1 hour per day for the rest of their lives to stretch, in an effort to treat and prevent contractures.

There is animal evidence to indicate a reduction in the number of serial sarcomeres of muscles immobilised in a shortened position,[4] while regular and prolonged stretch causes morphological changes with a resultant lasting increase in extensibility.[4,5] These studies give credence to the belief that stretch is effective for the treatment and prevention of contractures. These beliefs are further supported by strong anecdotal evidence along with the promising results of case studies and uncontrolled trials. However, the effects observed in case studies and uncontrolled trials may reflect bias or the effects of natural recovery or other

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co-interventions. It is therefore imperative to focus on randomised, controlled trials if a reliable answer is to be found as to whether stretch is effective for the treatment and prevention of contractures. This question was examined in a Cochrane Systematic Review in 2010[6] and in an updated review in 2017.[7] The present paper provides an abridged republication of the 2017 version of this Cochrane Systematic Review. It focuses on the short-term effects of stretch on joint mobility (effects present for < 1 week after the last stretch intervention), but includes the two key meta-analyses involving people with neurological and non-neurological conditions. The full review includes other outcomes and examines the long-term effects (effects present > 1 week after the last stretch intervention) as well as various sub-group analyses.

Therefore, the main research question for this systematic review was:

Does stretching improve joint mobility in the short term in people with neurological or non-neurological conditions?

Methods

All databases were searched up until November 2015 (see Cochrane Systematic Review[7] for full details) and potentially eligible trials screened for inclusion by two review authors. Disagreements between the two review authors were resolved by discussion and, when necessary, arbitrated by a third author. The following inclusion criteria were used to identify trials.

Participants: People of any age, including children, provided they either had or were deemed susceptible to contracture. This included conditions such as burns, arthritis, spinal cord injury, stroke and frailty.

Type of intervention: Any intervention that involved administering a stretch to maintain or increase the mobility of any synovial joint. The stretch needed to be administered on more than one occasion and for > 20 seconds. This included stretch administered through positioning programs, splints, serial casting or as part of manual therapy.

Comparisons: The stretch intervention needed to be compared to no stretch, placebo stretch or sham stretch. The stretch could also be compared to another intervention or usual care, provided the other intervention or usual care was also administered to the group receiving the stretch.

Outcomes: There were seven outcomes, including: joint mobility, quality of life, pain, activity limitation, participation restriction, adverse events and spasticity. However, for this publication we only report results for joint mobility. Joint mobility could be measured in many ways; the most common were: active range of motion (deg), passive range of motion (deg), passive joint stiffness (deg per unit torque) or linear distance between two points (eg, finger-tip to floor distance in mm).

Two review authors extracted joint mobility data for two time points: short term and long term. However, only the short-term effects are presented in this paper. This referred to effects present up to 1 week after the last stretch intervention. 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. Two meta-analyses were conducted by pooling studies involving people with neurological conditions and non-neurological conditions using a random-effects model. The data were only pooled if there was no evidence of clinical or statistical heterogeneity ($I^2 > 50\%$). In both meta-analyses the results were divided and also analysed by diagnosis. The pooled treatment effect was expressed as a mean difference if the outcomes in all the studies were the same and a standardised mean difference if they differed. Further sub-group analyses were conducted to explore the possibilities that the effectiveness of stretch depends on different factors, including the size of the joint or muscle that is stretched and whether stretch is administered for the treatment or prevention of contractures (see Cochrane Systematic Review for full details). Here we just report the results of the sub-group analyses exploring the possibility that the effectiveness of stretch depends on the dosage of stretch and the way in which the stretch is administered. All data were analysed using Review Manager 5.[a]

Trials were assessed for risk of bias using the Cochrane Risk of Bias Tool. Each trial was rated as high risk, unclear risk or low risk on the following domains: sequence generation; concealed allocation; blinding of participants and therapists; blinding of outcome assessors for objective outcomes; blinding of outcome assessors for subjective outcomes; incomplete outcome data; selective outcome reporting and other potential threats of bias. The GRADE approach was used to evaluate the quality of evidence in each meta-analysis as high, medium, low or very low. This approach takes into account: susceptibility to bias; directness of evidence; heterogeneity or inconsistencies in the results; imprecision; and probability of publication bias.

Results

A total of 5048 papers were screened for inclusion and 135 were potentially eligible. Ultimately, 49 studies involving 2135 participants met the inclusion criteria, with 28 studies involving 898 participants with neurological conditions and 21 studies involving 1237 participants with non-neurological conditions. All studies measured joint mobility, but some did not provide useable data and others did not measure joint mobility within 1 week of the last intervention.

The risk of bias in the 49 studies was variable (see Figure 1). Approximately half of the studies were rated as low risk of bias for each of the eight domains. No study blinded participants or therapists, as this is not possible in trials involving stretch. All studies compared stretch and a co-intervention to a co-intervention only. The co-interventions included usual care, botulinum toxin, passive stretches, exercise and therapy. Joint mobility was measured in degrees in all but four studies involving non-neurological conditions (see Table 1).

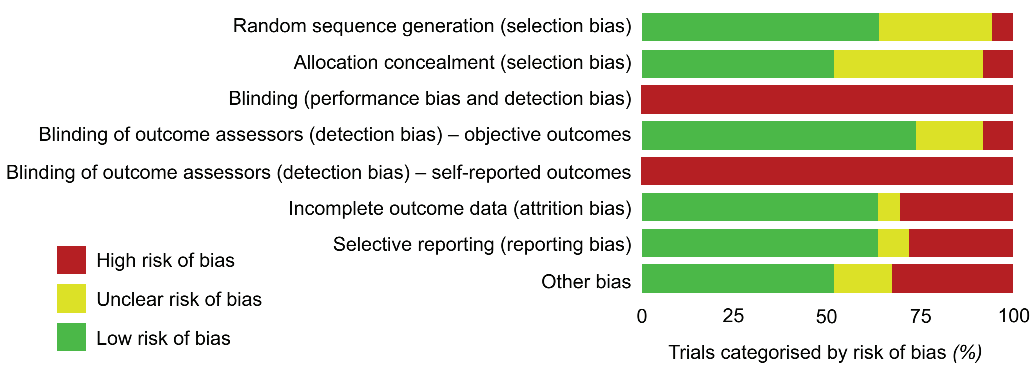

Figure 1. Risk of bias of included trials.

Table 1
Characteristics of the included trials (n = 49). The shaded trials were excluded from the quantitative analyses.

Author	Health condition	Sample size	Joint of interest	Groups	Dosage of stretch	Outcome included in this review
Neurological conditions						
Ackman 2005[35]	Children with spastic cerebral palsy	Exp: 13 Con: 12 Oth: 14	Ankle	Exp: Botulinum toxin plus cast Con: Botulinum toxin Oth: Placebo plus cast	24 hrs × 7 d × 9 wks = 1512 hrs over a 9-wk period	Passive ankle dorsiflexion with the knee extended (deg)
Ada 2005[9]	Adults with stroke	Exp: 18 Con: 18	Shoulder	Exp: Two 30-min sessions of shoulder positioning Con: Up to 10 min of shoulder exercises and routine upper-limb care	30 min × 5 d × 4 wks = 10 hrs for each position over a 4-wk period	Maximum passive shoulder external rotation of the affected limb (deg)
Basaran 2012[10]	Adults with stroke	Exp: 13 Con: 13 Other: 13	Wrist	Exp: Volar splint and home-based exercise program Con: Home-based exercise program only Other: Dorsal splint and home-based exercise program	10 hrs × 7 d × 5 wks = 350 hrs over a 5-wk period	Passive wrist extension (deg)
Ben 2005[11]	Adults with spinal cord injury	Exp: 20 legs Con: 20 legs	Ankle	Exp: Weight-bearing and stretch Con: Non weight-bearing and non stretch	30 min × 3 d × 12 wks = 18 hrs over a 12-wk period	Passive ankle dorsiflexion (torque controlled; deg)
Bürge 2008[12]	Adults with stroke	Exp: 31 Con: 16	Wrist	Exp: Orthosis plus conventional care Con: Conventional care	Total stretch time not reported	Wrist range of motion (Fugl-Meyer Assessment sub-scale)
Copley 2013[13]	Adults with acquired brain injury	Exp: 6 Con: 4	Wrist and fingers	Exp: Splint and standard practice occupational therapy program Con: Standard practice occupational therapy program only	10 hrs × 90 d = 900 hrs over a 13-wk period	Wrist extension with the fingers extended (deg)
Crowe 2000[14]	Adults with spinal cord injury	Exp: 18 Con: 21	Shoulder	Exp: Positioning plus conventional care Con: Conventional care	45 mins × 5 d × (2 to 16 wks) = 7.5 hrs to 60 hrs over a 2 to 16-wk period	Passive shoulder abduction (right arm; deg)
De Jong 2006[15]	Adults with stroke	Exp: 10 Con: 9	Shoulder	Exp: Positioning plus conventional care Con: Conventional care	30 mins × 2 sessions × 5 d × (5 to 10 wks) = 25 to 50 hrs over a 5 to 10-wk period	Passive shoulder abduction (deg)
Dean 2000[16]	Adults with stroke	Exp: 14 Con: 14	Shoulder	Exp: Shoulder positioning plus conventional care Con: Conventional care	3 sessions × 20 mins × 5 d × 6 wks = 30 hrs over a 6-wk period	Passive shoulder external rotation (deg)
DiPasquale-Lehnerz 1994[17]	Adults with spinal cord injury	Exp: 7 Con: 6	Hand	Exp: Positional orthosis plus conventional rehabilitation Con: Conventional rehabilitation	8 hrs × 7 d × 12 wks = 672 hrs over a 12-wk period	Passive metacarpophalangeal extension (deg)
Gustafsson 2006[18]	Adults with stroke	Exp: 17 Con: 17	Shoulder	Exp: Shoulder positioning plus conventional care Con: Conventional care	24 hrs × 30 d = 720 hrs over a 4-wk period	Passive shoulder external rotation (deg)
Harvey 2000[19]	Adults with spinal cord injury	Exp: 14 legs Con: 14 legs	Ankle	Exp: Stretch Con: Non-stretch	30 mins × (5 to 7 d) × 4 wks = 10 to 14 hrs over a 4-wk period	Ankle angle at 10 Nm torque with the knee extended (deg)
Harvey 2003[8]	Adults with spinal cord injury	Exp: 16 legs Con: 16 legs	Hip	Exp: Stretch Con: Non-stretch	30 mins × 5 d × 4 wks = 10 hrs over a 4-wk period	Hip flexion at 30 Nm torque (deg)
Harvey 2006[20]	Adults with spinal cord injury, stroke or traumatic brain injury	Exp: 30 thumbs (spinal cord injury 19, stroke 7, traumatic brain injury 4) Con: 30 thumbs (spinal cord injury 20, stroke 7, traumatic brain injury 3)	Thumb carpometacarpal	Exp: Thumb splint Con: No splint	8 hrs × 7 d × 12 wks = 672 hrs over a 12-wk period	Palmar abduction of the thumb carpometacarpal joint (deg)
Hill 1994[21]	Adults with brain injury	Exp: 8 Con: 7	Elbow and wrist	Exp: Serial casting Con: Therapy	24 hrs × 7 d × 4.33 wks = 728 hrs over a 4-wk period	Unidirectional passive joint ROM (deg)
Horsley 2007[22]	Adults with stroke or stroke-like brain injury	Exp: 20 Con: 20	Wrist	Exp: Stretch plus usual care Con: Usual care	30 mins × 5 d × 4 wks = 10 hrs over a 4-wk period	Passive wrist extension (deg)
Hyde 2000[23]	Children with Duchenne muscular dystrophy	Exp: 15 Con: 12	Ankle	Exp: Night splint plus passive stretch Con: Passive stretch	Total stretch time not reported	Tendo-achilles contracture
Krumlinde-Sundholm 2011[24]	Children with cerebral palsy (12 children had unilateral and 14 bilateral cerebral palsy)	37 children (cross-over) Exp: not specified Con: not specified	Wrist and thumb	Exp: Hand splint and usual care Con: Usual care	8 hrs × 7 d × 26 wks = 1456 hrs over a 26-wk period	Passive wrist extension (deg)

Table 1 (*Continued*)

Author	Health condition	Sample size	Joint of interest	Groups	Dosage of stretch	Outcome included in this review
Lai 2009[25]	Adults with stroke	Exp: 15 Con: 15	Elbow	Exp: Extension splint plus botulinum toxin and therapy Con: Botulinum toxin and therapy	6 to 8 hrs × 7 d × 14 wks = 588 hrs to 784 hrs over a 14-wk period	Maximal active elbow extension (deg)
Lannin 2003[27]	Adults with stroke or brain injury	Exp: 17 Con: 11	Wrist (long finger flexors)	Exp: Splint plus routine therapy Con: Routine therapy	12 hrs × 7 d × 4 wks = 336 hrs over a 4-wk period	Passive wrist extension (deg)
Lannin 2007[26]	Adults with stroke	Exp: 21 Con: 21 Other: 21	Wrist (long finger flexors)	Exp: Wrist extension splint and usual rehabilitation Con: No splint and usual rehabilitation Other: Neutral wrist splint	12 hrs × 7 d × 4 wks = 336 hrs over a 4-wk period	Passive wrist extension (deg)
Law 1991[28]	Children with spastic cerebral palsy	Exp: 19 Con: 18 Other 1: 17 Other 2: 18	Wrist (wrist flexors)	Exp: Cast plus intensive neurodevelopmental therapy Con: Intensive neurodevelopmental therapy Other 1: Cast plus regular neurodevelopmental therapy Other 2: Regular neurodevelopmental therapy	4 hrs × 7 d × 26 wks = 728 hrs over a 26-wk period	Wrist range of motion (scale not reported)
McNee 2007[34]	Children with cerebral palsy	Exp: 5 Con: 4	Ankle	Exp: Cast Con: No cast	24 hrs × 7 d × (3 to 4 wks) = 504 to 672 hrs over a 3 to 4-wk period	Passive ankle dorsiflexion with the knee extended (deg)
Moseley 1997[29]	Adults with traumatic brain injury	Exp: 5 Con: 5	Ankle	Exp: Cast Con: No cast	24 hrs × 7 d = 168 hrs over a 1-wk period	Passive ankle dorsiflexion (deg)
Refshauge 2006[30]	Children and young adults with Charcot-Marie-Tooth disease	Exp: 14 legs Con: 14 legs	Ankle	Exp: Night splint Con: No splint	4 to 9 hrs × 7 d × 6 wks = 78 to 168 hrs over a 6-wk period	Passive ankle dorsiflexion (deg)
Rose 2010[31]	Children and young adults with Charcot-Marie-Tooth disease and restricted ankle dorsiflexion range	Exp: 15 Con: 15	Ankle	Exp: Night cast for 4 wks followed by stretches in standing for 4 wks Con: No intervention	(6 to 10 hrs × 7 d × 4 wks) + (1 min × 6 times per day × 7 d × 4 wks) = 170.8 to 282.2 hours over an 8-wk period	Ankle dorsiflexion during a lunge test (deg)
Sheehan 2006[32]	Adults with stroke	Exp: 6 Con: 8	Wrist (finger flexors)	Exp: Splint Con: No splint	8 hrs × 7 d × 1 wk = 56 hrs over a 1-wk period	Resistance at 20 deg extension (N)
Turton 2005[33]	Adults with stroke	Exp: 14 Con: 15	Wrist and shoulder	Exp: Stretch plus usual care Con: Usual care	2 wrist stretches × 30 min × 7 d × 12 wks = 84 hrs over a 12-wk period	Passive wrist extension of the affected arm (deg)
Non-neurological conditions						
Aoki 2009[36]	Adults with knee osteoarthritis	Exp: 17 (33 knees) Con: 19 (33 knees)	Knee	Exp: Home-based stretch Con: Maintain usual physical activity	5 min × 7 d × 11.6 wks = 6.7 hrs over a 12-wk period	Knee range of motion in supine (deg)
Buchbinder 1993[37]	Adults post-radiation therapy for the jaw	Exp: 9 Con: 5 Other: 7	Mandibular	Exp: Therabite System plus unassisted exercise Con: Unassisted exercise Other: Stacked tongue depressors plus unassisted exercise	5 repetitions × 30 s × (6 to 10 sessions) × 7 d × 10 wks = 17.5 to 29.2 hrs over a 10-wk period	Maximal incisal opening (mm)
Bulstrode 1987[38]	Adults with ankylosing spondylitis	Exp: 27 Con: 12	Hip	Exp: Stretch plus conventional care Con: Conventional care	Total stretch time not reported	Hip extension with knee in extension (deg)
Collis 2013[39]	Adults following surgical release for Dupuytren's contracture	Exp: 26 Con: 30	Hand	Exp: Night extension orthosis plus hand therapy Con: Hand therapy alone	8 hrs × 7 d × 12 wks = 672 hrs over a 12-wk period	Active extension of the little finger (sum of metacarpophalangeal, proximal interphalangeal and distal interphalangeal joints; deg)
Cox 2009[40]	Adults with oral submucous fibrosis	Exp: 23 Con: 16 Other: 15	Jaw/mouth	Exp: Physiotherapy (stacked tongue depressors) plus conventional care Con: Conventional care Other: Hyaluronidase and steroid injections plus conventional care	5 min × 5 sessions × 7 d × 17 wks = 49.6 hrs over a 17-wk period	Maximal inter-incisal opening (mm)
Fox 2000[41]	Elderly nursing-home residents	Exp: 9 Con: 9	Knee	Exp: Bed positioning program (low-load prolonged knee stretch) Con: No intervention	40 min × 4 d × 8 wks = 21.3 hrs over an 8-wk period	Passive knee extension (deg)
Horton 2002[42]	Adults following total knee replacement	Exp: 27 Con: 28	Knee	Exp: Splint Con: No splint	24 hrs × 2 d = 48 hrs over a 2-d period	Knee fixed-flexion deformity (deg)
Hussein 2015[43]	Adults with shoulder adhesive capsulitis	Exp: 30 Con: 30	Shoulder	Exp: Static progressive stretch device plus traditional therapy Con: Traditional therapy	(30 min × 7 d × 1 wk) + (60 min × 7 d × 2 wks) + (90 min × 7 d × 1 wk) = 28 hrs over a 4-wk period	Active shoulder abduction (deg)

Table 1 (*Continued*)

Author	Health condition	Sample size	Joint of interest	Groups	Dosage of stretch	Outcome included in this review
Jang 2015[44]	Adults with recent (< 30 d) burns around the shoulder joint	Exp: 11 Con: 13	Shoulder	Exp: Shoulder splint and usual care Con: Usual care	24 hrs × 7 d × 4 wks = 672 hrs over a 4-wk period	Active shoulder abduction (deg)
Jerosch-Herold 2011[45]	Adults following surgical release for Dupuytren's contracture	Exp: 77 Con: 77	Hand	Exp: Static night splint plus hand therapy Con: Hand therapy	8 hrs × 182 d = 1456 hrs over a 26-wk period	Active extension of the metacarpophalangeal, proximal interphalangeal and distal interphalangeal joint of the operated fingers (deg)
John 2011[46]	Adults with hallux limitus in the first metatarsophalangeal joint following surgery	Exp: 25 Con: 25	Metatarsophalangeal joint of great toe	Exp: Dynamic splint and usual care Con: Usual care	3 hrs × 7 d × 8 wks = 168 hrs over an 8-wk period	Active dorsiflexion at the first metatarsal joint of the hallux (great toe; deg)
Jongs 2012[47]	Adults with contracture following distal radial fracture	Exp: 19 Con: 21	Wrist	Exp: Splint and routine care Con: Routine care	6 hrs × 7 d × 8 wks = 336 hrs over an 8-wk period	Passive wrist extension (deg)
Kemler 2012[48]	Adults with Dupuytren's disease	Exp: 28 Con: 26	Proximal interphalangeal	Exp: Hand splint and usual therapy Con: Usual therapy	(24 hrs × 28 d) + (8 hrs × 7 d × 7 wks) = 1064 hrs over an 11-wk period	Passive extension of proximal interphalangeal joint (deg)
Kolmus 2012[49]	Adults with an axillary burn (anterior chest involving the axillary fold, anterior, lateral or posterior shoulder and the axillary region)	Exp: 27 Con: 25	Shoulder	Exp: Shoulder splint and usual care Con: Usual care	(24 hrs × 7 d × 6 wks) + (8 hrs × 7 d × 6 wks) = 1344 hrs over a 12-wk period	Shoulder range of abduction (deg)
Lee 2007[50]	Adult women following radiotherapy for breast cancer	Exp: 31 Con: 30	Shoulder	Exp: Stretch plus usual care Con: Usual care	10 min × 2 muscles × 2 sessions × 7 d × 30.33 wks = 141.5 hrs over a 30-wk period	Passive shoulder horizontal extension of the affected arm (deg)
Melegati 2003[55]	Adults with primary anterior cruciate ligament reconstruction	Exp: 18 Con: 18	Knee	Exp: Knee extension brace Con: Range of motion brace	23 hrs × 7 d = 161 hrs over a 1-wk period	Passive knee extension (heel height difference in cm)
Moseley 2005[51]	Adults with ankle fracture	Exp: 51 Con: 50 Other: 49	Ankle	Exp: Long-duration stretch plus exercise Con: Exercise Other: Short-duration stretch plus exercise	30 min × 7 d × 4 wks = 14 hrs over a 4-wk period	Ankle dorsiflexion angle at peak baseline torque with knee straight (deg)
Paul 2014[52]	Adults with adhesive capsulitis (frozen shoulder)	Exp: 50 Con: 50	Shoulder	Exp: Stretch with countertraction device and usual care Con: Usual care	10 min × 5 d × 2 wks = 1.7 hrs over a 2-wk period	Shoulder flexion (deg)
Seeger 1987[53]	Adults with systemic sclerosis (scleroderma)	Exp: 19 hands Con: 19 hands	Proximal interphalangeal	Exp: Splint Con: No splint	8 hrs × 7 d × 8 wks = 448 hrs over an 8-wk period	Combined proximal interphalangeal passive extension (deg)
Steffen 1995[54]	Elderly people with bilateral knee contractures	Exp: 14 Con: 14	Knee	Exp: Knee splint (prolonged stretch) plus passive range of motion exercises and manually administered stretches Con: Passive range of motion exercises and manually administered stretches	3 hrs × 5 d × 26 wks = 390 hrs over a 26-wk period	Passive knee extension (deg)
Zenios 2002[56]	Adults following total knee replacement	Exp: 42 Con: 39	Knee	Exp: Splint Con: No splint	23 hours × 3 days = 69 hours over a 3-day period	Knee fixed flexion (passive knee extension; deg)

The effects of stretch in people with neurological conditions

Twenty-six studies with a total of 699 participants investigated the short-term effects on joint mobility following stretch in people with neurological conditions.[8–33] Two additional studies only measured the long-term effects of stretch and are not included here.[34,35] Eighteen studies with a total of 549 participants provided sufficient data, and all studies measured joint mobility.[8–11,13,15,16,18–20,22,25–27,29–31,33] The participants included people with stroke, Charcot-Marie Tooth disease, acquired brain injury and spinal cord injury. The mean difference was 2 deg (95% CI 0 to 3, $I^2 = 37\%$, $p = 0.009$) (see Figure 2, and Figure 3 on the eAddenda for a detailed forest plot). This is equivalent to a relative change of 2% (95% CI 0 to 3). The GRADE quality of evidence for this result was high.

The effects of stretch in people with non-neurological conditions

Nineteen studies with a total of 925 participants investigated the short-term effects on joint mobility following stretch in people with non-neurological conditions.[36–54] Two additional studies only measured the long-term effects of stretch and are not included here.[55,56] All 19 studies provided sufficient data and all but two studies measured joint mobility in degrees.[37,40] There was substantial statistical heterogeneity between studies ($I^2 = 67\%$) and the standardised mean difference was 0.3 SD (95% CI 0.1 to 0.6). The main reason for this heterogeneity was one study,[43] in which the results for two of the three outcomes were between 5 and 30 times greater than the results for any other study. There was no obvious explanation for this but the extreme results all favouring the experimental condition seemed implausible. Therefore, 18 studies with a total of 865 participants were included in the present analyses.[36–42,44–54] The participants included frail elderly and people with ankle fracture, anklylosing spondylitis, oral submucous fibrosis, post radiation therapy to the breast, post-radiation therapy to the jaw, progressive systemic sclerosis, total knee replacement, arthritis, Dupuytren's contractures, shoulder adhesive capsulitis/frozen shoulder, hallux limitus, wrist fracture and burns. The standardised mean difference was 0.2 SD (95% CI 0.0 to 0.3, $I^2 = 27\%$, $p = 0.06$) (see Figure 4, and Figure 5 on the eAddenda for a detailed forest plot). This translates to an absolute mean increase of 1 deg (95% CI 0 to 2) when the results are back converted using the largest, least biased and most representative study of those included in the analysis.[51] This is equivalent to a relative change of 1% (95% CI 0 to 2). The GRADE quality of evidence for this result was high.

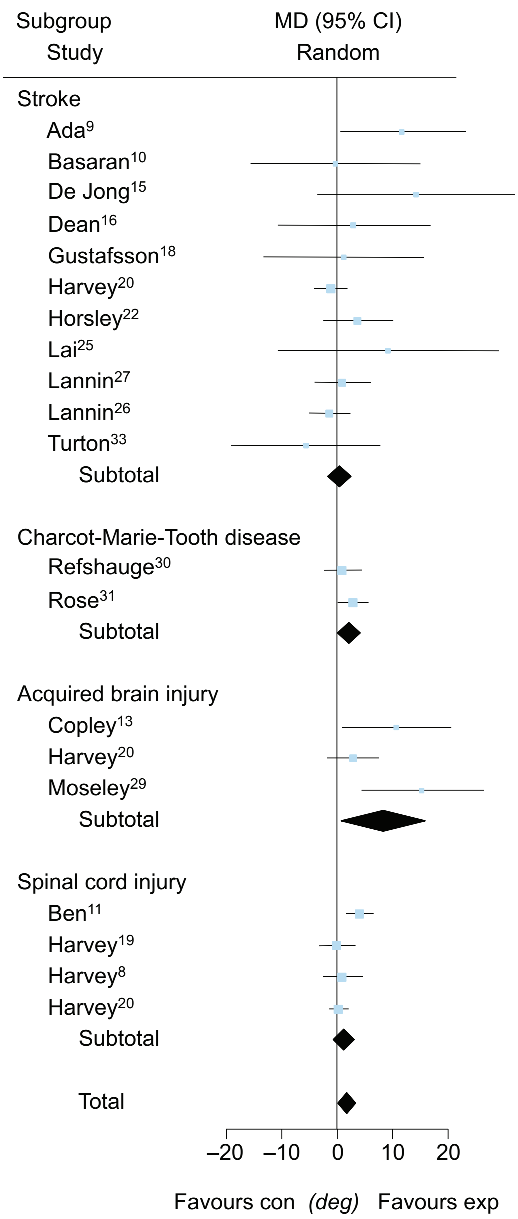

Figure 2. Mean difference (95% CI) in immediate effect of stretch versus control on joint mobility in people with neurological conditions. Subtotals are presented for each clinical condition.

Sub-group analyses

The dosage of stretch

Thirty-seven studies with a total of 1519 participants measured joint mobility in degrees, and provided sufficient data to estimate the effect of mean total stretch time on joint mobility.[8–11,13,15,16,18–20,22,25–27,29,30,33–36,38,39,41–54,56] As mean time data were skewed, they were transformed by taking the natural logarithm of time. Total stretch time was adjusted for the length of time between randomisation and measurement, as well as the length of time between the last stretch and measurement using multiple meta-regression. The mean difference was 0 deg for each log hour increase in total stretch time (95% CI –1 to 1, $I^2 = 31\%$, $p = 0.119$).

The way the stretch is administered

Thirty-seven studies with a total of 1530 participants measured joint mobility in degrees, and provided sufficient data to estimate the effect of different stretch interventions on joint mobility.[8–11,13,15,16,18–20,22,25–27,29,30,33–36,38,39,41–54,56] The overall effect of administering stretch in five different ways was examined. This included stretch administered with serial casting, positioning, splinting, self-administration and other ways. The effect of stretch on joint mobility was not influenced by the way stretch was administered (test for subgroup differences; $p = 0.33$), although these results need to be interpreted with caution because some subgroups only included two studies.

Discussion

There is high-quality evidence that stretch does not have clinically important effects on joint mobility. The pooled mean treatment effect for neurological and non-neurological conditions is 2 deg and 1 deg, respectively. These estimates are very precise, with the upper end of the 95% CI spanning to 3 deg and 2 deg, respectively. So unless readers consider a maximal possible treatment effect of 3 deg to be clinically worthwhile, these results conclusively indicate that stretch does not change joint mobility. These findings are robust in most sensitivity and sub-group analyses, and are based on the results of 36 studies involving 1414 participants. The participants included people with a range of different diagnoses, including spinal cord injury, acquired brain injury, stroke, ankylosing spondylitis, oral submucous fibrosis, systemic sclerosis, ankle fracture and arthritis. The studies were categorised and analysed on the basis of whether the underlying

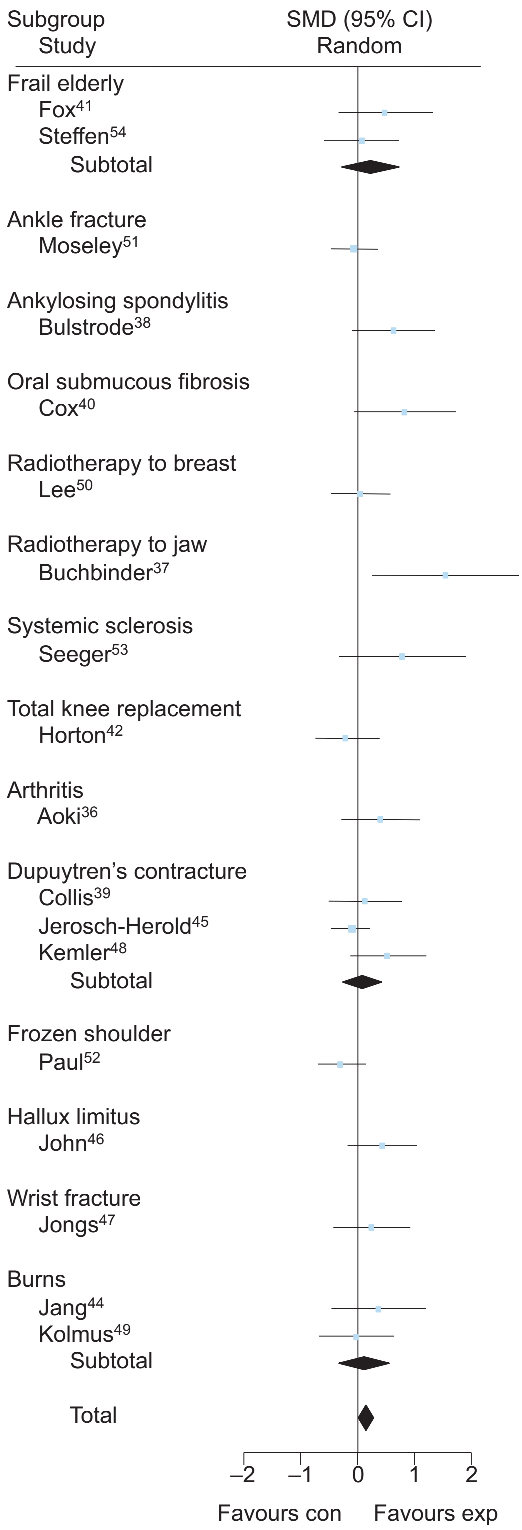

Figure 4. Standardised mean difference (95% CI) in immediate effect of stretch versus control on joint mobility in people with non-neurological conditions. Subtotals are presented only where multiple trials examined the same clinical condition.

condition was neurological or non-neurological, to guard against the possibility that the effectiveness of stretch differs depending on the involvement of the nervous system. However, there was no indication that this was the case. Nor was there any evidence that the effects of stretch differed between different types of neurological or non-neurological conditions. The only exception was acquired brain injury. The point estimates for people with acquired brain injury was very imprecise, failing to rule in or rule out a clinically important treatment effect. These results therefore need to be interpreted with caution.

There are two important caveats to our findings. Firstly, no study administered stretch for > 7 months, with most studies applying stretch for between 4 and 12 weeks. It is possible that the effects of stretch accumulate over time. If this is the case, regular stretching applied for many years as part of a home maintenance program for people with spinal cord injury, stroke and other similar conditions, may ultimately yield clinically important effects on joint mobility. It is unfortunate that studies looking at the effects of stretch administered for such periods of time are unlikely to ever be conducted. For this reason, uncertainty will remain about the worth of these sorts of stretching programs. The second important caveat is that no study compared stretch, as typically incorporated into routine nursing care, with nursing care that did not incorporate stretch. The results of our review are therefore potentially harmful if people extrapolate the findings to mean that it is acceptable for semi-comatosed or paralysed patients to lie flexed in bed with no attention to the position of their limbs. We do not advocate this and do not believe that this is a valid interpretation of our results.

This republication of the updated 2017 Cochrane Systematic Review[7] does not include the results of the other outcomes that were investigated. These include quality of life, pain, activity limitation, participation restriction, adverse events and spasticity. However, in the updated 2017 Cochrane Systematic Review[7] it was concluded that it is uncertain whether stretch has clinically important short-term effects on pain (standardised mean difference 0.2, 95% CI –0.1 to 0.5, five studies with 174 participants) or activity limitations (standardised mean difference 0.2, 95% CI –0.1 to 0.5, eight studies with 247 participants) in people with neurological conditions, and the effects of stretch on quality of life or participation restrictions are unknown. The effects of stretch in people with non-neurological conditions are somewhat clearer. For example, there is high-quality evidence that stretch does not have clinically important effects on pain (standardised mean difference –0.2, 95% CI –0.4 to 0.1, seven studies with 422 participants) and moderate quality evidence that stretch does not have clinically important effects on quality of life (standardised mean difference 0.3, 95% CI –0.1 to 0.7, two studies with 97 participants). However, the effects of stretch on activity limitations and participation restrictions in people with non-neurological conditions are also uncertain. The long-term effects are either more ambiguous or have not been investigated. There are some reports of adverse events predominantly from studies that applied stretch through splints or plaster casts. The adverse events included numbness, pain, swelling, skin breakdown, bruising and blisters.

It is unlikely that further studies will change the results of this review. There may, however, be value in examining the effects of stretch administered with other interventions. For example, stretch administered with motor training or botulinum toxin in people with neurological conditions. There may also be worth in specifically investigating the effectiveness of stretch administered for extended periods of time (eg, years). In addition, there may be value in further exploring the effectiveness of stretch for the prevention of contracture, particularly in those at very high risk of developing severe contracture (eg, people with traumatic brain injury). For example, there is no way of knowing whether the studies included in this review that claimed to include people at risk of contracture included people who subsequently went on to develop contracture. If those who are likely to develop severe contracture could accurately be predicted, these individuals could be selectively recruited to studies. However, it is proving more difficult than commonly assumed to accurately predict those likely to develop severe contractures.[1,2]

The results of this Cochrane Systematic Review are challenging for the physiotherapy profession because they contradict a fundamental assumption that physiotherapists have made for a long time. Namely, that stretch is effective for the treatment and prevention of contracture. However, the evidence is now compelling that stretch does not have clinically meaningful effects on joint mobility and that these results are robust to many different sub-group analyses. However, caution is recommended before extrapolating these results to stretch applied regularly for many months or years. The effectiveness of stretch administered for such extended periods of time is unknown.

What is already known on this topic: Contractures can occur with many types of injuries and disabilities. Stretch is commonly used by physiotherapists for the treatment and prevention of contractures.
What this study adds: High-quality evidence indicates that stretch does not have clinically worthwhile short-term effects on joint mobility. The effectiveness of stretch administered for many months or years is unknown.

Footnotes: [a]Review Manager 5 The Cochrane Collaboration, Copenhagen, Denmark.

eAddenda: Figures 3 and 5 can be found online at http://dx.doi.org/10.1016/j.jphys.2017.02.014.

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