# There is inconsistent evidence that prolonged low load stretching is effective in minimising loss of external rotation PROM following stroke

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**CLINICAL SCENARIO:** Reduced passive range of motion (PROM) in the elbow, wrist and finger flexors and shoulder internal rotator muscle groups is common following acquired brain impairment (ABI). This reduced PROM /impairment is often a barrier to function, upper limb rehabilitation and occupational performance. Reduced PROM is also often associated with pain and other long term secondary complications. Prolonged low load stretching of these four upper limb muscle groups is commonly implemented by physiotherapists and/or occupational therapists to maintain PROM. What is the evidence to support the use of this intervention for this population?

**FOCUSSED CLINICAL QUESTION:** Among people with upper limb paralysis following acquired brain impairment (including stroke), does prolonged low load stretching, result in maintained or improved upper limb PROM when compared to standard therapy?

**Summary of Findings** Three level 2b studies were located and appraised

***(a) Ada et al (2005):*** Level 2b evidence; 30 minutes of positioning in external rotation and $45^0$ abduction, five days per week, was effective in slowing down, but not preventing loss of external rotation PROM early after stroke (within 7 weeks post stroke). Wide confidence intervals. Absence of torque control for the intervention and measurement raises some doubt as to the validity and generalisation of these findings (Harvey, 2005)

***(b) Dean et al (2000):*** Level 2b evidence; statistically insignificant 'trend' towards decreased PROM loss for clients within 10 weeks post stroke receiving 3 different 20 minute stretches 5 days per week for 6 weeks. Study underpowered.

***(c) Turton et al (2005)*:** Level 2b evidence; no clinically or statistically significant improvement in PROM demonstrated following a 12 week low load stretching program for shoulder internal rotators and wrist and finger flexors. Wide confidence intervals. Study underpowered

**CLINICAL BOTTOM LINE:** The overall effectiveness of prolonged low load stretches for the maintenance of upper limb PROM following acquired brain impairment remains unclear.

**Limitation of this CAT:** This critically appraised paper has been peer-reviewed by one independent person.

## SEARCH STRATEGY:

***Search terms:***

- ***P****atient group*: CVA; Stroke; ABI; TBI; Head Injury; Brain Injury
- ***I****ntervention*: Stretch$, +/- low load; prolonged low load, PROM; PROM Exercise$, positioning
- ***C****omparison*: Standard therapy; routine therapy
- ***O****utcomes*: PROM; Torque controlled PROM; spasticity; resistance to PROM

***Search sites/ resources searched:***

- ✔ The Cochrane Library (www.cochrane.org)
- ✔ PEDro Database (www.pedro.fhs.usd.edu.au)
- ✔ OTseeker (www.otseeker.com) and OT-CATS (www.otcats.com)
- ✔ MEDLINE/CINAHL
- ✔ RCT.com
- ✔ Google (www.google.com.au)

***Inclusion criteria:***

- ✔ Studies investigating subjects with Acquired Brain impairment
- ✔ Level of evidence 2b or higher
- ✔ Full-text of study available/published in English

**Exclusion Criteria:**

- ✕ Studies investigating Botulinum Toxin treatment combined with stretching
- ✕ Studies investigating casting or casting combined with stretching

## RESULTS OF SEARCH

A total of 31 relevant citations were located and abstracts screened .
Three studies met selection criteria as shown in Table 1 (based on levels of evidence as defined by the Oxford Centre for Evidence-based Medicine (Ball, et al., 2001)

**Table 1. LEVELS OF EVIDENCE FOR STUDIES EVALUATING INTERVENTION EFFECTIVENESS**

| LEVEL | STUDY DESIGNS | Number located |
|---|---|---|
| Ia | **Systematic reviews (SR) of RCT's** (RCT= control group✓ random allocation✓) | 0 |
| Ib | Individual **RCT's** of good quality | 0 |
| 2a | SR of cohort studies (Cohort Study = control group✓ random allocation✕ – identification of a cohort receiving the intervention/factor and one not, then comparing the outcomes). | 0 |
| 2b | Individual **cohort studies** and low quality **RCT's** | 3 |
| 3a | SR of case control studies (Case Control Study = control group✓ random allocation✕ – identification of a group of patients with the outcome/disease and a group without, then looking back to see whether they were exposed to the intervention being investigated). | excluded |
| 3b | Individual **case control** study | excluded |
| 4 | **Case Series** and poor quality **case control and cohort studies** (Case series = control group✕ random allocation✕ - a single group of subjects is exposed to the intervention and their outcomes measured). | excluded |
| 5 | **Expert opinion** | excluded |

## BEST EVIDENCE

Three RCT's were selected and appraised for this CAT. Reasons for selecting these papers included:

- Level 2b randomised controlled trials
- Target population.
- Met all other inclusion/exclusion criteria

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## SUMMARY OF BEST EVIDENCE

**Table 2:** Description and appraisal of RCT by Ada, Goddard et al (2005)[1].

***Aim of the Study:*** To determine the efficacy of positioning the affected shoulder in flexion and external rotation to prevent contractures shortly after stroke.

***Study design:*** Single blind, centrally randomised controlled trial

***Participants and setting:*** 36 patients selected from four inpatient rehabilitation units in Sydney, Australia.

**Eligibility criteria**:
1. Acute stroke (< 20 days)
2. Hemiplegia with 0-4 rating on Motor Assessment Scale item 6
3. Between 50 and 80 years old

**Exclusion *criteria:***
1. Pre-existing shoulder problem (loss of $>20^0$ of intact shoulder ROM in external rotation or flexion)
2. Cognitive impairment precluding participation in positioning program

**INTERVENTION*:***

***Experimental*** (n= 18) ***:***
(1) 30 minutes of upper limb positioning* in supine with maximal shoulder external rotation (with gravity) and 45° shoulder abduction),
(2) 30 minutes in $90^0$shoulder flexion at a table with neutral shoulder rotation
(3) Standard care: up to 10 minutes of shoulder exercises, slings and arm supports.

*Stretches/positioning carried out five days per week for four weeks.

**Control** (n =18): Standard care (as above).

***Primary outcome measure:***
- Maximum PROM in external rotation, (ER) and forward flexion, (FF). Measured with a standardised procedure involving fluid goniometer and force of gravity on the arm.

***Secondary measures***:
- % with/without contracture in internal rotators (loss of ER)
- % with/without contracture in shoulder extensors (loss of FF)
- Upper limb function = Motor Assessment Scale (MAS) item 6,
- pain during measurement = Visual Analogue Scale.

Measurements were taken at baseline and 4 weeks when treatment ceased by a blinded assessor.

**Results:**

*Subject Loss to Follow-Up:* Five dropouts (13%) all within 20 days post stroke (8% from exp group and 13% from control group). Therefore, 87% available for follow-up measure at four weeks.

1. *Shoulder external rotation:*

- *PROM:* at post test loss of external rotation was significantly greater in the control group than the experimental (P=.05). This translated to a significantly larger external rotation contracture (contracture expressed as % loss of total PROM) (P=.03). For the intervention group, stretching prevented $12^0$ (95% CI, $0^0$ to $24^0$) loss of shoulder external rotation which was translated into prevention of 17% of contracture (95% CI, 1% to 32%). Authors suggest that intention to treat analysis diluted these results. An analysis excluding dropouts yielded a prevention of loss of PROM of $18^0$ (95% CI, $4^0$ to $33^0$) and 25% (95% CI, 7% to 43%) of contracture.
- *Pain:* There were fewer patients with pain on external rotation in the experimental group (33%) than the control group (50%) but this difference was not statistically significant.

2. *Shoulder flexion*: There was no significant difference between the incidence of shoulder extensor contracture between groups, or occurrence of pain on passive flexion between groups (40% and 38% respectively).
3. *Function:* Both groups showed small improvements in function that were not significantly different from each other.
4. Compliance: Experimental subjects on average received 84% of prescribed treatment sessions.
5. *NB*: the treatment did not totally prevent contracture in the experimental subjects ; most subjects lost some ER range.

***Original Authors' Conclusions****:* Stroke patients with little upper limb function should undergo a program of positioning the affected shoulder in $45^0$ abduction and maximum external rotation for at least 30 minutes per day five days per week.

**Critical Appraisal:**

**Validity**:
PEDro rating score (partitioned score from OTseeker) = 8/10: indicating an RCT of good quality (Moseley et al, 2000).

1. Eligibility criteria specified: yes
2. Random allocation: yes
3. Concealed allocation: yes
4. Groups similar at baseline regarding important prognostic indicators: yes
5. Blinding of subjects: no
6. Blinding of therapists: no
7. Blinding of all assessors: yes
8. Key outcome measures obtained from 85% of initially allocated subjects: yes
9. Intention to treat analysis: yes
10. Between groups statistical comparisons: yes
11. Point measures and measures of variability: yes

*Primary Outcome Measure*:

- ✔ Used a standardised procedure for measuring.
- ✘ The lack of torque control for the measurement and intervention raises a validity question. Harvey (2005) argues that without torque control during assessment and intervention, changes in PROM cannot necessarily be equated with changes in muscle length. With out a consistent force applied, any changes in PROM could be as a result of changes in patient muscle relaxation.
- ✔ Limited number of measures appropriate to reduce statistical error.

*BIAS*:

- *Selection*: no
- *Measurement*: no
- *Intervention*: no

*Power calculations*: not provided or explicitly stated to be sufficient.

**Results**:

- Mean treatment effect ($11.8^0$ in favour of intervention group) was statistically and clinically significant but confidence intervals were relatively wide ($0^0$ to $24^0$) and inclusive of point of no effect for the main measure.
- An additional follow up measure would have yielded some valuable data on the maintenance of a treatment effect

.*Level of evidence*: 2b (Ball et al 2001), due to validity concern with primary outcome measure (Harvey, 2005), and lack of a power calculation.

**Summary:**
Level 2b evidence suggests that 30 minutes of positioning in external rotation and $45^0$ abduction, five days per week, is effective in minimising loss of external rotation PROM for clients early after stroke (within 7 weeks post stroke). Results to be interpreted with some caution due to validity concerns with outcome measure and unknown statistical power.

**Table 3:** Description and appraisal of RCT by Dean, Mackey and Katrak (2000) [2]

***Aim of the study:***To investigate the effect of a shoulder positioning protocol on shoulder joint pain and range in the affected upper limb.

***Study design:*** single blind, centrally randomised controlled trial

***Participants and setting:*** 28 subjects admitted to a Sydney hospital following stroke.

**Eligibility criteria**: less than 10 weeks post stroke, score < 5 on item 6 of the MAS, no premorbid shoulder pain or restriction of movement, PROM shoulder flexion and abduction > $90^0$ and able to comprehend visual analogue scale for pain.

**Exclusion criteria**: subjects with brainstem stroke.

***Intervention:***

***Experimental (n=14):***
20 minutes of upper limb positioning in each of three positions, five days per week for six weeks:

1. Maximal tolerable shoulder external rotation and abduction
2. Maximal tolerable shoulder external rotation and abduction of $90^0$
3. Shoulder flexion 900 seated with elbow extended

The group also participated in active training of reaching and manipulation.

**Control (n=14):**
Active training of reaching and manipulation as determined by treating therapist

***Primary outcome measures:***
- PROM to pain of shoulder external rotation using a gravity goniometer in supine

**Secondary measure:**
- Pain on dressing using VAS
- AROM of shoulder abduction in supine using a standard goniometer
- Pain at rest using the visual analogue scale (VAS)

***Results:***
1. *PROM:* No statistically significant difference between groups for external rotation (p=.63) and abduction (p=.135), but there were small trends favouring the experimental group. Both groups lost PROM.
2. *Pain:* No statistically significant difference between groups for pain at rest or on dressing but there were small trends favouring the experimental group. Pain decreased slightly for both groups at rest and on dressing post treatment.

***Authors' conclusions:*** The effect of a shoulder positioning program on pain and stiffness post stroke remains unclear. Trends in the results favoured the experimental group however, statistical significance was not achieved. This may have been for one or more of the following reasons:
1. Study underpowered, sample size only ¼ of calculated requirement.
2. Dosage of positioning too low.
3. Degree of measurement of PROM: Needed to collect shoulder flexion and abduction at 6 weeks from both groups as couldn't tell if control subjects had lost range in these movements.

**Critical Appraisal:**

**Validity**:
PEDro score= 7/10: Partitioned score (from OTseeker)

Eligibility criteria specified: yes
2. Random allocation: yes
3. Concealed allocation: yes
4. Groups similar at baseline regarding important prognostic indicators: yes
5. Blinding of subjects: no
6. Blinding of therapists: no
7. Blinding of all assessors: yes

8. Key outcome measures obtained from 85% of initially allocated subjects: no (only 10 subjects or 71% available for follow up measure)
9. Intention to treat analysis: yes
10. Between groups statistical comparisons: yes
11. Point measures and measures of variability: yes

*Outcome Measures*:

- A standardised reliable measure was used to measure ROM. Lack of torque control for this measure however, raises a question of its validity (as per previous study appraisal).
- A standardised and validised measure for pain was used
- Limited number of measures appropriate to reduce statistical error

*Sample Bias:* Subjects were up to 10 weeks post stroke and study criteria excluded patients with early existing contractures and/or pain. This sample bias may have masked a treatment effect.

*Power calculations*: Sample size too small to produce statistically significant results regarding treatment effect (calculation showed 46 subjects per group to detect $10^0$ PROM change with 80% accuracy).

**Results**:

- Trends in results favoured experimental group but no clinically or statistically significant treatment effect was demonstrated
- Sufficient means, standard deviations and other data were not provided making calculation of mean treatment effect or 95% CI untenable.
- Study result to be treated with caution as trial was underpowered and less than 85% of subjects had follow up measures.

L*evel of Evidence:* 2b lower quality RCT (Ball et al 2001), as statistically underpowered.

**Summary**:
Level 2b evidence suggests that prolonged positioning in external rotation for 20 minutes per day, five days per week for six weeks may have a beneficial effect on PROM. More high level evidence is needed to confirm or refute efficacy. Results to be interpreted with caution as study statistically underpowered.

**Table 4:** Description and appraisal of RCT by Turton and Britton (2005) 3

***Aim of the Study:*** *"*To evaluate the feasibility and effects of daily stretch positioning for prevention of contractures in stroke patients without arm function".

***Study design:*** single blind, centrally, randomised controlled trial

***Participants and setting:*** 29 patients (less dropouts) with acute stroke selected from 126 presenting to a stroke rehabilitation ward in the UK

**Eligibility criteria:** Primary diagnosis of first unilateral stroke within 4 weeks of onset. Inability to pick up polystyrene cup from table with affected hand.

**Exclusion *criteria:*** premorbid arm pain or arthritis, poor comprehension, confused state, dementia or medically unfit for treatment.

***Intervention:***

***Experimental (n= 12) :*** Two separate 30 minute non torque controlled prolonged low load stretches per day, five days per week for 12 weeks, for both the following positions:

1. Wrist and fingers extended in a wrist board
2. Shoulder abducted and externally rotated with elbow in extension (bedside table with pillow and sandbag)

Experimental subjects also received "standard care" including:

- Wheelchair arm support
- "Standard therapy"

***Control (n =11): "***Standard care" (as above)

***Primary outcome measure:***

- Passive range of motion (PROM) of wrist with fingers extended, and shoulder external rotation to standard torque or pain
- Measures taken at four (baseline), eight and 12 weeks post stroke.

***Secondary measure***:

Active range of motion (AROM) of the above joints at same intervals

**Results:**

- Patient groups roughly similar at baseline for outcome measures

- 14 patients randomised to experimental group. One patient withdrew from after four weeks. One additional patient missed measurement at eight weeks. All of this patient data was discarded, therefore final analysis based on 12 patients (85%).
- 15 patients randomised to control group, four patients withdrew with all measures discarded, therefore final analysis based on 11 patients (73%).

*Treatment compliance:*
- 7 experimental patients (58%) achieved the stated minimum treatment of one shoulder stretch per day, 5 days per week for four weeks, while 8 (66%) achieved this for the wrist and finger stretch.
- Only 1 patient (8%) achieved the stated optimum treatment of 2 stretches per day for the shoulder while 3 (25%) achieved this for the wrist

*Treatment effect:* No statistically or clinically significant mean differences in PROM or contracture between groups for any measures. Differences were small, insignificant and often favoured controls. For example, the mean difference (and 95% confidence interval) for wrist PROM at eight weeks was -2.1 degrees (CI - -9.1 to 13.36). Confidence intervals were wide (up to 30 degrees for some measures) and all crossed the line of no effect.

***Original Authors' Conclusions**:*

- Daily adherence to a demanding stretch regimes was poorly tolerated for more than three weeks.
- Considerable range of motion in shoulder and wrist is lost in the early weeks after stroke
- Study had low statistical power. A larger study is needed to demonstrate efficacy.

**Critical Appraisal:**

***Validity***:

*PEDro rating score* = 5/10 (un-partitioned score): indicating RCT of moderate quality (Moseley et al, 2000). Scored by author as follows:

1. Eligibility criteria specified: yes
2. Random allocation: yes
3. Concealed allocation: yes
4. Groups similar at baseline regarding important prognostic indicators: yes
5. Blinding of subjects: no
6. Blinding of therapists: no
7. Blinding of all assessors: no (stated that therapy assistant in the unit was blinded "where possible")
8. Key outcome measures obtained from 85% of initially allocated subjects: no (only 80% of controls at week 8 and 73% of controls at week 12)
9. Intention to treat analysis: no (authors stated that data for two subjects was discarded as they only completed two out of three measures)
10. Between groups statistical comparisons: yes
11. Point measures and measures of variability: yes

*Primary Outcome Measure*: a validised torque controlled method for measuring PROM at the shoulder and hand was used however, strict adherence to the referenced standardised method was not shown (wist was held in place on table instead of strapped into a device).
*BIAS*:

- *Selection*: no
- *Measurement*: Assessment was by investigator with a therapy assistant reading measures. Assessor was blind to allocation "where possible".
- *Intervention*: Intervention was carried out by a variety of ward staff (nurses, occupational therapists and physiotherapists) introducing potential inconsistencies in frequency and appropriate application of intervention. Patients with highest compliance were those attending regular physiotherapy, while those with pain were the lowest compliance (some ceased treatment early).

*Power calculations*: Study was underpowered therefore limiting the validity of findings and conclusions.

**Results**:
No clinically or statistically significant treatment effects were noted however,
Results to be interpreted with caution as:

- Study was a pilot trial and hence underpowered
- Follow up data was collected for less than 85% of control subjects
- Confidence intervals were wide and crossed line of no effect

*Level of evidence (Ball et al 2001)*: 2b (pilot RCT)

**Summary:** Level 2b evidence suggests that no clinically or statistically significant improvement in PROM was demonstrated for a 12 week low load stretching program for shoulder internal rotators and wrist and finger flexors (Turton et al 2005). Problems with validity, wide confidence intervals and low statistical power limits the generalisation of these findings.

## IMPLICATIONS FOR PRACTICE, EDUCATION AND FUTURE RESEARCH

Prolonged, low load upper limb stretching to prevent loss of PROM following brain impairment is commonly practiced by many Australian physiotherapists and some occupational therapists .The overall effectiveness and efficacy of this treatment for the target population remains unclear. In addition, no clear evidence exists to guide the duration, frequency and intensity of prolonged low load stretches, or to clarify any differences between muscle groups.

In view of the animal studies suggesting the efficacy of stretching, and now these higher level studies involving humans, it appears reasonable to continue the practice of prolonged low load stretching for all upper limb muscle groups except shoulder extensors. Treatment should be commenced as soon as possible after impairment to maximise effectiveness. Stretching programs are difficult and time intensive to implement, and therefore can be costly (i.e. time spent setting up treatments, monitoring, etc). It is therefore desirable if possible, to implement them in a resource efficient manner (e.g. teaching carers, relatives and other staff). Routine measuring of PROM in clinical practice is also recommended in order to monitor changes and effectiveness of treatment over time.

Further evaluation and research regarding the effectiveness of stretches is required in order to establish its efficacy. Future studies should focus on trying to achieve some of the following goals:

- Implement higher intensity and/or longer duration and/or higher frequency of stretches for longer periods, to try and identify a dose response curve (this may be difficult due to patient and staff compliance factors).
- Use of standardised, valid and reliable measures of PROM such as torque controlled goniometers.
- Identify and quantify the effect of early Vs delayed onset to treatment and its effect on outcome.
- Examine the effect of stretching on different joints and muscle groups.
- Ensure a large sample of sufficient statistical power to detect a clinically significant effect
- High follow up rate of subjects (>85%) with a longer follow up period such as two or three months to try to examine the maintenance of a treatment effect over time.

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