

There is little published evidence to support or refute the use of passive ranging to improve tenodesis hand function in people with C6 quadriplegia, in the first 6 months post-injury

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Clinical Question

"What is the effectiveness of passive wrist and hand ranging for improving tenodesis grasp in people with complete C6 quadriplegia, in the first six months post injury?"

Clinical Bottom Line

There is insufficient evidence to support or refute the use of passive ranging to improve hand function in people with quadriplegia.

Clinical Scenario

Tenodesis refers to opposition of the thumb and index finger with either active or passive wrist extension. Achieving a functional tenodesis grasp is a primary focus of therapy for such a person, to enable participation in activities of daily living. Tenodesis grasp is achieved with people who have a complete C6 level of quadriplegia, using a range of clinical interventions: passive wrist and hand ranging; active and /or resistive wrist extension exercises; hand splinting; and grasp/ release retraining using a graded programme of object size, reach and activities.

Passive ranging is performed daily at PA Hospital, Brisbane (protocol available from author). Education is provided by demonstration and in an education pamphlet about self- ranging. Current techniques assume that an effective tenodesis grasp is achieved by a decrease in the resting length of the flexor digitorum superficialis and profundus, so that the fingers flex when the wrist is extended. Full passive extension of the MCP and IP joints must be maintained so that fingers naturally extend when the wrist is in flexion, in order to achieve placement around an object. Also, stiffening of thumb IP joints in extension is facilitated by not ranging thumb interphalangeal flexion so as to achieve thumb alignment for "pad" pinch or "lateral" pinch. While this practice of tenodesis ranging has continued for many years, it is unclear as to the evidence on which this intervention is based.

Summary of Key Findings

- Six citations were located that met the inclusion/exclusion criteria.
- One RCT (Level 2b evidence) reported that standard therapy, defined as passive ranging to prevent joint loss of mobility, orthosis to prevent deformity, and active exercise of available muscles, proved as effective as using biofeedback or/and electrical stimulation in people with traumatic quadriplegia. No specific details on type of ranging programme/ speed or frequency provided.
- Level 2b (cohort study) and Level 5 evidence located indicated importance of passive ranging in achieving tenodesis grasp in people with C6 quadriplegia however no research evidence for a specific ranging programme ie type of stretches, frequency and repetitions.

Limitation of CAT

This summary of evidence has been individually prepared and has not undergone a process of formal peer review.

Methodology

Search Strategy

Using the levels of evidence as defined by the Oxford Centre for Evidence-based Medicine (Phillips, Ball, Sackett, et al., 2001), the search strategy aimed to locate the following study designs:

- Systematic reviews and meta-analyses of randomised controlled trials/RCTs (level 1a);
- Systematic reviews and meta-analyses of randomised and non-RCTs (level 2a);
- Randomised controlled trials (level 1b or 2b);
- Controlled trials, cohort (level 2b) or case-control studies (level 3b);
- Case series (level 4); or
- Expert opinion including literature/narrative reviews, consensus statements, descriptive studies and individual case studies (level 5).

A search was also conducted for clinical practice guidelines based on these levels of evidence.

Search Terms

Patient/Client: spinal cord injury, tetraplegia, quadriplegia

Intervention: passive exercise, passive joint motion, passive motion, tenodesis

Comparison: *nil*

Outcomes: hand function, tenodesis

Sites/Resources Searched

- Cochrane Library
- OTseeker – (Occupational Therapy Systematic Evaluation of Evidence (www.otseeker.com))
- PEDro – The Physiotherapy Evidence Database (www.pedro.fhs.usyd.edu.au/)
- Medline and CINAHL
- OTCATS (www.otcats.com)
- Google.com
- Library resources within the occupational therapy department and PAH Spinal Library
- Direct communication with professional colleagues/experts
- National benchmark questionnaire conducted in July/August 2002

Inclusion/Exclusion Criteria

Inclusion Criteria

- All study designs with an experimental focus (ie those that evaluated the effect of an intervention)
- Any year, English only
- Tetraplegia level of spinal injury only
- Studies including discussion on tenodesis in general terms as related to splinting, hand assessments, tendon transfers.

Exclusion Criteria

- Descriptive journal articles
- Studies focused on FES; and external/ Neuro prosthetic devices
- Animal studies
- Incomplete spinal cord injury
- Joints other than wrist/hands

Results

Results of Search

Articles with related information relevant to this clinical question in terms of passive ranging, splinting and hand management were sourced to determine relevancy to this question.

A total of 13 publications were sourced with 6 relevant publications considered to meet inclusion criteria for review, and these were categorised as follows:

Table 1. Study designs of articles retrieved by search

Methodology of Studies Retrieved	Number Located	Source of Evidence
Systematic Reviews or Meta – analyses	0	
Randomised Controlled Trials	1	Cochrane; OT Seeker Author: Kohlmeyer et al (1996) Reference: 1
Controlled trials or cohort studies	0	
Case series: Post – test only, Pre - test/Post - test	0	
Expert opinion including literature/narrative reviews, consensus statements, descriptive studies and individual case studies	5	CINAHL; Medline References: 2 - 7

Specific Results

Critical appraisal of the quantitative literature was conducted using the McMaster Critical Appraisal tool. (<http://www.fhs.mcmaster.ca/rehab/ebp/>).

Table 2. Description and Appraisal of **Level 2b** evidence from Kohlmeyer et al (1996).

<p>Objective of Study : To evaluate the effectiveness of 4 treatment modalities - conservative management which included passive ranging, biofeedback, electrical stimulation and combination of biofeedback and electrical stimulation - on the recovery of tenodesis grasp.</p> <p>Methods Study Design: Randomised Control Trial: 2 x 2 block design with subjects randomised to treatment groups.</p> <p>Sample: 45 individuals were randomly assigned to one of 4 treatment groups. Subjects were recruited from inpatient population of a single rehabilitation institution from 1988-1993. For all subject it was their first admission for rehab after an acute SCI. Criteria for selection included individuals with traumatic tetraplegia, with poor grade anterior deltoid and/or biceps and trace wrist extensor. Any person whose spasticity clinically interfered with function or therapy was excluded.</p> <p>Measures: Each individual was assessed using a 10 scale manual muscle test and a 4 item self -feeding task. The evaluator of these measures was blinded as to the treatment the patient was receiving. The study does not report the background of the evaluator, nor their relationship to the study.</p> <p>Intervention Groups: Individuals were randomly assigned to one of the 4 treatment groups. All subjects received the same duration of treatment: 20 minute session, daily for 5 to 6 weeks.</p> <ol style="list-style-type: none"> (1) Conventional Treatment: Passive range of motion (PROM), orthotic intervention, strengthening of available muscles by exercise and involvement of the available musculature in functional activities. (2) Electrical Stimulation Treatment: Patient received five 20 minute periods of cyclic electrical stimulation per week for 5 to 6 weeks. (3) Biofeedback Treatment: Subjects were set-up on a biofeedback machine and attempted to perform wrist extension while receiving electromyogram (EMG) auditory and visual feedback. Subject were instructed to watch the EMG visual screen and 'lift your wrist and follow the pattern (different patterns presented sequentially) as best you can'. (4) Electrical feedback and Biofeedback: Combination of the two treatments, with the 20 minute treatment time divided in half between the two modalities.
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Primary Outcome: Improvement of wrist extensor strength and functional tenodesis grasp.

Data Analysis: Chi square, Non parametric Kruskal-Wallis one way ANOVA and Spearman Rank Correlation.

Results

There was no statistical difference in the mean improvement between the four treatment groups in wrist extensor strength or the functional tenodesis grasp (Primary outcome measure), nor on any of the other muscle groups measured. Improvement in muscle grade and functional skills was evident for all four intervention groups.

Conclusions

Biofeedback and electrical stimulation alone, or in combination, offer no advantages over conventional rehabilitation treatment for wrist extensors and development of functional tenodesis grasp in tetraplegic patients after spinal cord injury.

This study has been reviewed for the OTseeker database (www.otseeker.com) and given the following score on the PEDro (partitioned) scale:

Internal Validity Score: **3/8**

Statistical Reporting Score: **1/2**

Total Score: **4/10**

Reviewer Appraisal Comments

Validity

- Sample was randomly allocated. No description provided on process for random allocation to treatment groups.
- No concealed allocation
- Does not report who is carrying out treatment. Would be beneficial to know how many therapists providing treatment? What profession are they from? What level of training do they have in the treatment techniques? Etc.
- Good baseline comparability established. A non-parametric Kruskal-Wallis one-way ANOVA revealed that there was no difference between the four treatment groups with respect to muscle grade or functional score on baseline assessment. Subject characteristics (e.g. Age, time post-injury) also had good comparability.
- Used blind evaluator however did not report relationship of evaluator to research.
- Subjects were not blinded to treatment receiving.
- Does not report on other treatment the subjects may be receiving - possible co intervention bias?
- Timing of assessment for outcome measure was not clearly stated. It is clear that baseline measures were taken, but one can only assume the outcome measures were reassessed to establish results immediately following the 5-6 week treatment period, or throughout? No further follow-up was apparently done to seeing lasting affect or ongoing improvement of subjects.
- Drop-outs reported. Stated that during the study 15 subjects were found to be unsuitable (typically uncooperative in treatment sessions), declined to complete the study, or were discharged before study completed.

Author Results

- Clear report of methods of statistical analysis used and for what component of data analysis.
- Reported between group comparisons: nil statistical difference found between the four groups.
- Results reported in terms of statistical significance.
- Results not reported in terms of clinical importance.
- Conclusions were clearly related to results.

Clinical Bottom Line:

The outcome of this study provides useful information in addressing the clinical question. This study indicates that the conventional method of intervention (including passive hand ranging), increases wrist extensor strength and functional tenodesis grasp (Primary outcome measures for this study) as do the other three interventions measured. No significant difference was found between electrical stimulation or biofeedback and conventional treatment.

Critical appraisal of this study revealed several flaws in this study design, predominantly with internal validity. Several variables were not controlled (or not reported). Further evidence is required to substantiate these results and allow generalisation to the treatment for people with tetraplegia.

ADDITIONAL COMMENTARY ON OTHER STUDIES APPRAISED

Level 5 Evidence

(1) Hill (p.50-52;1986) and Pedretti and Zoltan (p.589 & 590;1990) explain the clinical protocol for tenodesis ranging, from which the PAH SIU OT department appears to have based the current practise, that is, "When performing tenodesis passive ranging finger and thumb extension is performed with the wrist flexed. Finger and thumb flexion is performed with the wrist extended. This enhances tenodesis function by promoting shortening of the finger flexors for grasp when the wrist is extended and tightening of the finger extensors for improved release with the wrist flexed". However these authors give no research evidence for their recommendations.

(2) Several researchers agree that "regular passive movements" are required to prevent loss of mobility and joint stiffness (Frank et al, 1984; Harvey, 1996; Kohlmeyer et al,1996; Sutton,1993).

(3) Frank et al (1984) provide a general overview of the physiology and therapeutic value of passive joint motion stating studies have shown that repeated motion (active and passive) stretches and lubricates tissues and also alters metabolic activity. Motion promotes decreased scar adherence to surrounding tissue and acts to inhibit contracture and stiffness of joints. This descriptive article emphasizes serious concern re the lack of specificity when discussing passive motion in terms of forces, velocities, directions.

(4) Tierney, 1982, described a programme which includes daily passive movements to avoid counteracting the shortening effect of splinting. The MCP and IP joints are extended only when wrist is held in flexion.

(5) More specifically, Harvey (1996) states that the aim of therapy is "to promote the shortening in the FDP, FDS, and FPL muscles". She provides an outline and rationale for splint designs enhancing tenodesis based on the principle that prolonged immobilisation enhances muscle shortening whereas ranging prevents loss of range particularly the prevention of loss of MCP and IP extension. She also states that it is 'desirable' to promote the stiffening of IP joint of the thumb to ensure that with wrist extension the MCP joint of the thumb flexes rather than the IP joint. From these statements one can infer that a passive ranging program should include ranging of the IP joints of the fingers but not of the thumb. As mentioned previously though, this is a descriptive study and not a randomised control study.

(6) A survey of Senior Occupational Therapy clinicians working in Australian Spinal Injury Units was conducted in July 2002 to identify expert opinion and current practice in the management of hand function for people with spinal injury. All facilities (n=8) responded, refer to Appendix B for summary of results. All 8 facilities conducted tenodesis ranging as part of Occupational therapy programme for individuals with complete C6 Tetraplegia. There is no consistency however in terms of rationale for ranging, nor agreement in terms of method or frequency of ranging or frequency of joint repetitions.

A review of literature was commenced but not completed into fields of animal studies and passive ranging in other joints with some initial findings of interest to this clinical question in terms of repetitions and length of stretch.

IMPLICATIONS FOR PRACTICE

The most effective method of performing passive ranging in individuals with complete C6 tetraplegia remains unclear. Level 2 and 5 evidence appraised has heightened our awareness to the possibility that current practice is perhaps based more on maintaining range of motion in the paralysed wrist and hand muscles, rather than facilitating the development of tenodesis grasp. Ranging is perhaps preventing the overstretching of extrinsics and maintaining ROM in all joints.

Based on Level 5 evidence, it is desirable to encourage stiffening into extension of the IP joint of the thumb. This will cause the thumb to contact rather than curl under the index finger during wrist extension. There is insufficient evidence to support or refute current practice in terms of frequency, speed, precise positioning.

PRACTICE RECOMMENDATIONS

1. Passive hand ranging for individuals with complete C6 tetraplegic clients should continue (level 2b, level 5)
2. Passive techniques of stretching the MCPs and IPs joints into extension with the wrist in flexion and the MCPs and IPs flexed with the wrist in extension should continue (level 2b and level 5)
3. Maintaining the thumb IP joint in extension is important in attaining alignment of thumb to index finger (level 5)
4. Continue with existing protocol mindful that not all aspects of the protocol are supported by research.

These recommendations are general guidelines only and should be interpreted in the context of the individual patient and therapist's judgement.

Future research

- Collaborate with the current multi centre national project in Australia aimed at establishing consensus on splinting protocols as this may consolidate evidence that prolonged immobilisation facilitates shortening of long finger flexors rather than or in addition to passive ranging .
- Investigate/develop assessment of tenodesis grasp as no such outcome measure is available
- Determine feasibility of conducting randomised control trials on a small sample group in order to establish a sound clinical protocol for ranging the tenodesis hand.
- Further review of animal studies as this relates to muscle stretches.
- Revise clinical protocol and patient self ranging handout

OVERALL CONCLUSION

There is a small amount of research that has investigated the effectiveness of interventions to maintain or improve hand function and grasp in people with quadriplegia. A similar statement was also made some years ago: "It is surprising that so little research has been done on the tenodesis grip, which is so fundamental to these patients independence"(Harvey, 1996) .

This CAT indicates a need to further investigate treatments that aim to improve tenodesis grasp.

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Articles critically appraised for this summary of evidence:

Level 2b Evidence

1. Kohlmeier, K.M., Hill, J.P., Yarkony, G.M., & Jaeger, R.J. (1996). Electrical Stimulation and Biofeedback Effect on Recovery of Tenodesis Grasp: A Controlled Study. *Archives of Physical Medicine and Rehabilitation* 77, 702-706. .

Level 5 Evidence

2. Frank, C., Akeson, W.H., Woo, S.L-Y, Arniel, D., & Coutts, R.D.(1984). Physiology and therapeutic value of passive joint motion. *Clinical Orthopaedics and Related Research*, 185, 113- 125.
3. Harvey, L. (1996). Principles of Conservative Management for a Non-orthotic Tenodesis Grip in Tetraplegics. *Journal of Hand Therapy*, 9, 238-242.

4. Hill, J. (1986) Spinal cord Injury: A Guide to functional outcomes in Occupational therapy. Aspen publishers.p50-52.
5. Pedretti, L., & Zoltan, B. (1990). Occupational Therapy: Practice skills for Physical Dysfunction, 3rd Ed. CV Mosby Company .p 589,590.
6. Sutton, S. (1993). An Overview of the Management of the C6 Quadriplegic Patient's hand: An Occupational Therapist's Perspective. *British Journal of Occupational Therapy*, 56, 376-30.
7. Tierney, N. (1982). The development of tenodesis or a 'trick' pincer grip by the C6 quadriplegic. *Proceedings of the 8th Conference of the World Federation of Occupational Therapists, Vol. 1.*, Hamburg, WFOT, p351

Other References

Phillips B., Ball C., Sackett, D., Badenoch D., Straus S., Haynes B., Dawes M. (1998). Levels of evidence and grades of recommendations. <http://cebm.jr2.ox.ac.uk/docs/levels.html> Accessed on 6/07/2002.