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**Literature search results**

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**Search details**

Efficacy of splinting of the hand or upper limb for those patients suffering spasticity in these areas after stroke

**Resources searched**

NHS Evidence; National Library for Health; Cochrane Library; TRIP database; MEDLINE, CINAHL; EMBASE; Google Scholar; Google Advanced Search

**Database search terms:** stroke; STROKE; “transient ischaemic attack”; TIA; CEREBRAL ISCHEMIA; TRANSIENT; “cerebrovascular accident”; spastic*; neurology*; splint*; SPLINTS; MUSCLE SPASTICITY; hand; exp HAND; “upper limb”; “upper arm”; exp UPPER EXTREMITY; contracture; exp CONTRACTURE; “functional ability”; FUNCTIONAL STATUS; exercise*; stretch; STRETCHING

**Google search string:** stroke spasticity (hand or "upper limb") (splinting or stretching)

**Summary**

There is not a huge amount of research in this area, and none directly comparing the efficacy of splinting over stretching in the rehabilitation of stroke patients with spasticity in the upper limb. Both are regarded as treatment options. The research, based on abstracts, (please note that there are a few interesting articles for which no abstract available, so you’ll have to request the full-text) seems to indicate that hand splinting can be effective 4, 9, 26, but not in the case of increased extensibility of long finger flexor muscles 16. and one study declares there is insufficient evidence for their effectiveness 31. Stretching may be effective 29, 35 but not in the case of thumb web-space contractures in neurological conditions 18.
Guidelines

**SIGN**

Management of patients with stroke: Rehabilitation, prevention and management of complications, and discharge planning 2002

The few high quality RCTs investigating the relative efficacy of different physiotherapy treatments provide no evidence that any one treatment approach improves functional ability more effectively than any other.

**European Stoke Association**

Guidelines for management of ischaemic stroke and transient ischaemic attack (new elements) 2009

Physiotherapy is recommended, but the optimal mode of delivery is unclear.

**Royal College of Physicians**

National clinical guidelines for stroke 2004

Spasticity should not limit the use of strength training. In patients with disabling or symptomatically distressing spasticity, injection of botulinum toxin should be considered in conjunction with physiotherapy for reducing tone and/or increasing the range of joint motion.

Guidelines for the use of botulinum toxin (BTX) in the management of spasticity in adults 2002

Includes guidance on splinting.

**Evidence based reviews**

**NHS Quality Improvement Scotland**

Manual passive stretching for adults unable to move their own joints 2005

There is insufficient direct evidence to be confident that manual passive stretching is clinically effective for prevention or treatment of contracture in adults at risk due to neurological conditions or unconsciousness.

**Published research**

- 1. Modulation of stretch reflexes of the finger flexors by sensory feedback from the proximal upper limb poststroke

  **Author(s):** Hoffmann G., Kamper D.G., Kahn J.H., Rymer W.Z., Schmit B.D.

  **Citation:** Journal of Neurophysiology, September 2009, vol./is. 102/3(1420-1429), 0022-3077;1522-1598 (September 2009)

  **Publication Date:** September 2009

  **Abstract:** Neural coupling of proximal and distal upper limb segments may have functional implications in the recovery of hemiparesis after stroke. The goal of the present study was to investigate whether the stretch reflex response magnitude of spastic finger flexor muscles poststroke is influenced by sensory input from the shoulder and the elbow and whether reflex coupling of muscles throughout the upper limb is altered in spastic stroke survivors. Through imposed extension of the metacarpophalangeal (MCP) joints, stretch of the relaxed finger flexors of the four fingers was imposed in 10 relaxed stroke subjects under different conditions of proximal sensory input, namely static arm posture (3 different shoulder/elbow postures) and electrical stimulation (surface stimulation of biceps brachii or triceps brachii, or none). Fast (300degrees/s) imposed stretch elicited stretch reflex flexion torque at the MCP joints and reflex electromyographic (EMG) activity in flexor digitorum
superficialis. Both measures were greatest in an arm posture of 90 degrees of elbow flexion and neutral shoulder position. Biceps stimulation resulted in greater MCP stretch reflex flexion torque. Fast imposed stretch also elicited reflex EMG activity in nonstretched heteronymous upper limb muscles, both proximal and distal. These results suggest that in the spastic hemiparetic upper limb poststroke, sensorimotor coupling of proximal and distal upper limb segments is involved in both the increased stretch reflex response of the finger flexors and an increased reflex coupling of heteronymous muscles. Both phenomena may be mediated through changes poststroke in the spinal reflex circuits and/or in the descending influence of supraspinal pathways. Copyright copyright 2009 The American Physiological Society.

Source: EMBASE

2. Elastic, viscous, and mass load effects on poststroke muscle recruitment and co-contraction during reaching: a pilot study.

Author(s): Stoeckmann TM, Sullivan KJ, Scheidt RA

Citation: Physical Therapy, 01 July 2009, vol./is. 89/7(665-678), 00319023

Publication Date: 01 July 2009

Abstract: BACKGROUND: Resistive exercise after stroke can improve strength (force-generating capacity) without increasing spasticity (velocity-dependent hypertonicity). However, the effect of resistive load type on muscle activation and co-contraction after stroke is not clear. OBJECTIVE: The purpose of this study was to determine the effect of load type (elastic, viscous, or mass) on muscle activation and co-contraction during resisted forward reaching in the paretic and nonparetic arms after stroke. DESIGN: This investigation was a single-session, mixed repeated-measures pilot study. METHODS: Twenty participants (10 with hemiplegia and 10 without neurologic involvement) reached forward with each arm against equivalent elastic, viscous, and mass loads. Normalized shoulder and elbow electromyography impulses were analyzed to determine agonist muscle recruitment and agonist-antagonist muscle co-contraction. RESULTS: Muscle activation and co-contraction levels were significantly higher on virtually all outcome measures for the paretic and nonparetic arms of the participants with stroke than for the matched control participants. Only the nonparetic shoulder responded to load type with similar activation levels but variable co-contraction responses relative to those of the control shoulder. Elastic and viscous loads were associated with strong activation; mass and viscous loads were associated with minimal co-contraction. LIMITATIONS: A reasonable, but limited, range of loads was available. CONCLUSIONS: Motor control deficits were evident in both the paretic and the nonparetic arms after stroke when forward reaching was resisted with viscous, elastic, or mass loads. The paretic arm responded with higher muscle activation and co-contraction levels across all load conditions than the matched control arm. Smaller increases in muscle activation and co-contraction levels that varied with load type were observed in the nonparetic arm. On the basis of the response of the nonparetic arm, this study provides preliminary evidence suggesting that viscous loads elicited strong muscle activation with minimal co-contraction. Further intervention studies are needed to determine whether viscous loads are preferable for poststroke resistive exercise programs.

Source: CINAHL

Full Text:
Available in fulltext at EBSCO Host
Available in fulltext at EBSCO Host


Author(s): Sorinola IO, White CM, Rushton DN, Newham DJ

Citation: Neurorehabilitation & Neural Repair, 01 March 2009, vol./is. 23/3(287-294), 15459683

Publication Date: 01 March 2009

Abstract: BACKGROUND: The management of spasticity is important in
neurorehabilitation and needs to be assessed accurately. The commonly used clinical tools have been criticized for lack of validity and sensitivity. **OBJECTIVE:** To investigate the reliability of electromyographic (EMG) response to manual stretches of the hemiplegic wrist and its correlation with clinical assessments of spasticity and physical function. **METHODS:** EMG activity was measured in 10 stroke patients and control participants (53.7 +/- 10 and 32 +/- 9.1 years respectively, mean +/- SEM) during 3 cycles of 10 seconds passive manual movements of the wrist at 60 to 360 degrees * s(-1). Isometric maximal voluntary contractions (MVC) strength, range of movement (ROM) of the wrist flexors and extensors, spasticity (Modified Ashworth Scale [MAS]) and hand function (Block and Box Test [BBT]) were also assessed. **RESULTS:** EMG activity of the stroke patients increased with velocity from 4% to 40% MVC (P < .001) but there was none in the controls. It was unaffected by repetition and good to moderate reliability occurred at all speeds (ICC, 0.71-0.81). EMG correlated negatively with MVC strength (r = -.9), active wrist flexion ROM (r = -.8), and hand function scores (r = -.7), but not with clinical measures of spasticity except at the lowest velocity (r = .72). **CONCLUSIONS:** Consistent and accurate stretch velocities and EMG responses can be achieved with manual wrist stretches for the assessment of the neural component of spasticity. These objective tests did not correlate well with the standard clinical assessment of spasticity. They showed significant negative relationships with function, indicating that increased reflex excitability contributes to hand disability after stroke.

**Source:** CINAHL

4. **Motor improvement and corticospinal modulation induced by Hybrid Assistive Neuromuscular Dynamic Stimulation (HANDS) therapy in patients with chronic stroke.**

**Author(s):** Fujiwara T, Kasashima Y, Honaga K, Muraoka Y, Tsuji T, Osu R, Hase K, Masakado Y, Liu M

**Citation:** Neurorehabilitation & Neural Repair, 01 February 2009, vol./is. 23/2(125-132), 15459683

**Publication Date:** 01 February 2009

**Abstract:** BACKGROUND: and objective . We devised a therapeutic approach to facilitate the use of the hemiparetic upper extremity (UE) in daily life by combining integrated volitional control electrical stimulation with a wrist splint, called hybrid assistive neuromuscular dynamic stimulation (HANDS). METHODS: . Twenty patients with chronic hemiparetic stroke (median 17.5 months) had moderate to severe UE weakness. Before and immediately after completing 3 weeks of training in 40-minute sessions, 5 days per week over 3 weeks and wearing the system for 8 hours each day, clinical measures of motor impairment, spasticity, and UE functional scores, as well as neurophysiological measures including electromyography activity, reciprocal inhibition, and intracortical inhibition were assessed. A follow-up clinical assessment was performed 3 months later. **RESULTS:** . UE motor function, spasticity, and functional scores improved after the intervention. Neurophysiologically, the intervention induced restoration of presynaptic and long loop inhibitory connections as well as disynaptic reciprocal inhibition. Paired pulse transcranial magnetic stimulation study indicated disinhibition of the short intracortical inhibition in the affected hemisphere. The follow-up assessment showed that improved UE functions were maintained at 3 months. **CONCLUSION:** . The combination of hand splint and volitional and electrically induced muscle contraction can induce corticospinal plasticity and may offer a promising option for the management of the paretic UE in patients with stroke. A larger sample size with randomized controls is needed to demonstrate effectiveness.

**Source:** CINAHL

5. **Constraint-induced movement therapy for upper extremities in stroke patients.**

**Author(s):** Sirtori V., Corbetta D., Moja L., Gatti R.

**Citation:** Cochrane database of systematic reviews (Online), 2009, vol./is. /4(CD004433), 1469-493X (2009)

**Publication Date:** 2009

**Abstract:** BACKGROUND: In stroke patients, upper limb paresis affects many activities of
daily life. Reducing disability is therefore a major aim of rehabilitation programmes for hemiparetic patients. Constraint-induced movement therapy (CIMT) is a current approach to stroke rehabilitation that implies the forced use and the massed practice of the affected arm by restraining the unaffected arm. OBJECTIVES: To assess the efficacy of CIMT, modified CIMT (mCIMT), or forced use (FU) for arm management in hemiparetic patients. SEARCH STRATEGY: We searched the Cochrane Stroke Group trials register (last searched June 2008), the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library Issue 1, 2008), MEDLINE (1966 to June 2008), EMBASE (1980 to June 2008), CINAHL (1982 to June 2008), and the Physiotherapy Evidence Database (PEDro) (June 2008). SELECTION CRITERIA: Randomised control trials (RCTs) and quasi-RCTs (qRCTs) comparing CIMT, mCIMT or FU with other rehabilitative techniques, or none. DATA COLLECTION AND ANALYSIS: Two review authors independently classified the identified trials according to the inclusion and exclusion criteria, assessed methodological quality and extracted data. The primary outcome was disability. MAIN RESULTS: We included 19 studies involving 619 participants. The trials included participants who had some residual motor power of the paretic arm, the potential for further motor recovery and with limited pain or spasticity, but tended to use the limb little if at all. Only five studies had adequate allocation concealment. The majority of studies were underpowered (median number of included patients was 15) and we cannot rule out small-trial bias. Six trials (184 patients) assessed disability immediately after the intervention, indicating a significant standard mean difference (SMD) of 0.36, 95% confidence interval (CI) 0.06 to 0.65. For the most frequently reported outcome, arm motor function (11 studies involving 373 patients), the SMD was 0.72 (95% CI 0.32 to 1.12). There were only two studies that explored disability improvement after a few months of follow up and found no significant difference, SMD -0.07 (95% CI -0.53 to 0.40). AUTHORS’ CONCLUSIONS: CIMT is a multifaceted intervention: the restriction to the normal limb is accompanied by a certain amount of exercise of the appropriate quality. It is associated with a moderate reduction in disability assessed at the end of the treatment period. However, for disability measured some months after the end of treatment, there was no evidence of persisting benefit. Further randomised trials, with larger sample sizes and longer follow up, are justified.

Source: EMBASE

Full Text:
Available in fulltext at Wiley InterScience

6. Reliability and sensitivity of a wrist rig to measure motor control and spasticity in poststroke hemiplegia.

Author(s): Turk R, Notley SV, Pickering RM, Simpson DM, Wright PA, Burridge JH

Citation: Neurorehabilitation & Neural Repair, 01 November 2008, vol./is. 22/6(684-696), 15459683

Publication Date: 01 November 2008

Abstract: Background. Objective assessment of impairments after stroke is vital for evidence-based therapy and progress monitoring. Objective. This study determines the utility of outcome measures obtained from an instrumented wrist rig for future rehabilitation trials. The tests undertaken were evaluated in terms of sensitivity to detect differences between normal and impaired participants, test-retest repeatability (repeatability coefficient and intraclass correlation coefficient [ICC]), and interrater agreement (Bland and Altman limits of agreement). Methods . Twelve participants with chronic poststroke hemiparesis (mean 5.6 years); and 12 unimpaired volunteers performed a series of tasks in the rig. The hemiparetic arm (impaired group) and dominant arm (unimpaired group) were tested in 3 sessions on the same day by 2 assessors. Signals were analyzed to derive a tracking index (motor control), stretch index (spasticity), flexor modulation index (FMI) (muscle activation), force angle index (FAI) (stiffness), range of movement, and isometric force. Results and Conclusions. The means of all tests differed between impaired and unimpaired participants except for range of movement into flexion, the FAI, and the FMI. Repeatability coefficients for each test are presented as benchmark values for use in future trials in which the wrist rig tests may be used to detect change. Test-retest reliability was excellent in the impaired group (ICC = 0.88-0.98) and poor to excellent in the unimpaired group (ICC = 0.06-0.89). The Bland-Altman ranges showed no bias between assessors, and that the interrassessor variability was similar to that between repeats by the same assessor for most tests.
7. Spasticity measurement based on tonic stretch reflex threshold in stroke using a portable device

**Author(s):** Calota A., Feldman A.G., Levin M.F.

**Citation:** Clinical Neurophysiology, October 2008, vol./is. 119/10(2329-2337), 1388-2457 (October 2008)

**Publication Date:** October 2008

**Abstract:** Objectives: We investigated intra- and inter-evaluator reliability to quantify spasticity based on the tonic stretch reflex threshold (TSRT) and the correlation between TSRT and resistance to stretch. Methods: Spasticity was evaluated in 20 subjects with chronic stroke-related spasticity using a portable device and the Modified Ashworth Scale (MAS). Evaluations were done on 2 days, by three evaluators. Biceps brachii EMG signals and elbow displacement were recorded during 20 elbow stretches applied at different velocities for each evaluation. Velocity-dependent dynamic stretch reflex thresholds (angle where EMG signal increased in the biceps for a given velocity of stretch) were recorded. These values were used to compute TSRT (excitability of motoneurons at 0 degrees/s). Spasticity was also measured with MAS. Results: Reliability was moderately good for subjects with moderate to high spasticity (intra-evaluator: 0.46-0.68, and inter-evaluator: 0.53-0.68). The TSRT measure of spasticity did not correlate with resistance to stretch (MAS). Conclusions: TSRT may be a more representative measure for subjects with moderate to high spasticity. Further improvements are suggested for the portable device in order to quantify all the levels of spasticity. Significance: TSRT may be an alternative clinical measure to current clinical scales. copyright 2008 International Federation of Clinical Neurophysiology.

Source: EMBASE

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8. Splinting poststroke: The jury is still out

**Author(s):** Marosseyzky J.E., Gurka J.A., Baguley I.J.

**Citation:** Stroke, February 2008, vol./is. 39/2(e46), 0039-2499 (Feb 2008)

**Publication Date:** February 2008

**Source:** EMBASE

**Full Text:**
Available in fulltext at Highwire Press
Available in fulltext at Ovid

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9. Serial injection of botulinum toxin for muscle imbalance due to regional spasticity in the upper limb.

**Author(s):** Turner-Stokes L, Ashford S

**Citation:** Disability & Rehabilitation, 15 December 2007, vol./is. 29/23(1806-1812), 09638288

**Publication Date:** 15 December 2007

**Abstract:** Background and purpose. Three-dimensional movement in the upper limb presents a challenge for functional management of regional spasticity. Potential toxicity of botulinum toxin limits the number of muscles which may be injected in any one session. Serial injection may offer a solution, but carries theoretical risk of development of resistance due to antibody formation. This article reviews a small case series, gathered in a post-acute neuro-rehabilitation setting, to evaluate the use of serial botulinum toxin injection in terms of goal achievement and clinical evidence for toxicity or resistance. Methods. Nine patients with regional spasticity following acute stroke or brain injury had serial injection of botulinum toxin to muscle groups around the shoulder, elbow and/or wrist. Injection was followed by splinting/physiotherapy as appropriate. Goal attainment scaling was used to assess outcome. Results. Functional goals achieved were reduction of pain (n = 6/7) associated reaction (n = 4/5) or care needs (n = 5/6), improved gait (n = 2/3) or independence in self-
Two 'golden responder' cases are presented in detail to demonstrate resolution of symptoms with up to four serial injections of botulinum toxin over a period of up to 6 months. No clinical evidence of toxicity or resistance was seen in any case. Conclusion. These preliminary findings suggest that serial botulinum toxin injection followed by appropriate physiotherapy/splinting may provide effective treatment for regional spasticity. Resistance has not presented a problem in this post-acute situation, where treatment has not been required beyond a few months. Ongoing evaluation is underway.

Source: CINAHL

Full Text:
Available in fulltext at EBSCO Host

10. Effect of hand splinting: isn't temporality crucial?.

Author(s): Manigandan C, Charles J
Citation: Stroke, November 2007, vol./is. 38/11(e146; author reply e147), 0039-2499;1524-4628 (2007 Nov)
Publication Date: November 2007
Source: MEDLINE
Full Text:
Available in fulltext at Highwire Press
Available in fulltext at Ovid


Author(s): Levy CE, Giuffrida C, Richards L, Wu S, Davis S, Nadeau SE
Citation: American Journal of Physical Medicine & Rehabilitation, 01 September 2007, vol./is. 86/9(696-706), 08949115
Publication Date: 01 September 2007
Abstract: OBJECTIVE: To determine whether the combination of botulinum toxin A (BTX-A) treatment for the upper limb and a 4-wk course of exercise therapy could improve motor function sufficiently to allow those with poststroke hemiparesis and spasticity to achieve the minimal motor criteria (MMC) to be enrolled in constraint-induced movement therapy (CIMT), and to determine the feasibility of enrolling participants into CIMT if they meet MMC after treatment with a combination of BTX-A plus exercise therapy. DESIGN: Twelve individuals received BTX-A and exercise therapy for 1 hr/day, three times per week, for 4 wks. Those who met MMC were enrolled in 2 wks of CIMT, and the rest received a home exercise program. Outcome measures included the Ashworth Scale, Wolf Motor Function Test (WMFT), the Motor Activity Log (MAL), the Box and Blocks Test (BBT), and the upper-extremity subtest of the Fugl-Meyer Assessment of Motor Function (FM-UE). RESULTS: Ashworth Scale scores declined from a mean score of 2.0-1.2 (P = 0.01). Four of 12 subjects were able to achieve MMC (P = 0.026). CIMT participants improved in the BBT, the MAL, and the WMFT compared with their own baseline. Gains achieved during CIMT receded by week 24 as spasticity returned. CONCLUSION: BTX-A plus exercise therapy shows potential to improve function for those with severe hand paresis and spasticity after stroke. Those who meet MMC may initially realize further modest gains through CIMT. However, gains are likely to recede as spasticity returns. Adding medications or modifying the therapy protocol to include activities such as functional neuromuscular stimulation or robotic training may yield a more potent effect.
Source: CINAHL


Author(s): Shah S
Citation: Stroke, August 2007, vol./is. 38/8(e74; author reply e75), 0039-2499;1524-4628
13. Relationship between stretch reflex thresholds and voluntary arm muscle activation in patients with spasticity

Author(s): Musampa N.K., Mathieu P.A., Levin M.F.

Citation: Experimental Brain Research, August 2007, vol./is. 181/4(579-593), 0014-4819

Abstract: Previous studies have shown that deficits in agonist-antagonist muscle activation in the single-joint elbow system in patients with spastic hemiparesis are directly related to limitations in the range of regulation of the thresholds of muscle activation. We extended these findings to the double-joint, shoulder-elbow system in these patients. Ten non-disabled individuals and 11 stroke survivors with spasticity in upper limb muscles participated. Stroke survivors had sustained a single unilateral stroke 6-36 months previously, had full pain-free passive range of motion of the affected shoulder and elbow and had some voluntary control of the arm. EMG activity from four elbow and two shoulder muscles was recorded during quasi-static (<5degrees/s) stretching of elbow flexors/extensors and during slow voluntary elbow flexion/extension movement through full range. Stretches and active movements were initiated from full elbow flexion or extension with the shoulder in three different initial positions (60degrees, 90degrees, 145degrees horizontal abduction). SRTs were defined as the elbow angle at which EMG signals began to exceed 2SD of background noise. SRT angles obtained by passive muscle stretch were compared with the angles at which the respective muscles became activated during voluntary elbow movements. SRTs in elbow flexors were correlated with clinical spasticity scores. SRTs of elbow flexors and extensors were within the biomechanical range of the joint and varied with changes in the shoulder angle in all subjects with hemiparesis but could not be reached in this range in all healthy subjects when muscles were initially relaxed. In patients, limitations in the regulation of SRTs resulted in a subdivision of all-possible shoulder-elbow arm configurations into two areas, one in which spasticity was present (“spatial spasticity zone”) and another in which it was absent. Spatial spasticity zones were different for different muscles in different patients but, taken together, for all elbow muscles, the zones occupied a large part of elbow-shoulder joint space in each patient. The shape of the boundary between the spasticity and no-spasticity zones depended on the state of reflex inter-joint interaction. SRTs in single- and double-joint flexor muscles correlated with the positions at which muscles were activated during voluntary movements, for all shoulder angles, and this effect was greater in elbow flexor muscles (brachioradialis, biceps brachii). Flexor SRTs correlated with clinical spasticity in elbow flexors only when elbow muscles were at mid-length (90degrees). These findings support the notion that motor impairments after CNS damage are related to deficits in the specification and regulation of SRTs, resulting in the occurrence of spasticity zones in the space of elbow-shoulder configurations. It is suggested that the presence of spatial spasticity zones might be a major cause of motor impairments in general and deficits in inter-joint coordination in particular in patients with spasticity. copyright 2007 Springer-Verlag.

Source: EMBASE

14. Overnight splinting of the wrist in a neutral or extended position did not prevent contracture after stroke.

Author(s): Seneviratne C

Citation: Evidence-Based Nursing, 01 July 2007, vol./is. 10/3(86-86), 13676539

Publication Date: 01 July 2007
**Abstract:** Does overnight splinting of the wrist prevent contracture after stroke? Is splinting in an extended position more effective than splinting in a neutral position?

**Source:** CINAHL

**Full Text:**
Available in fulltext at Highwire Press

**15. Soleus muscle strengthening: impact on gait kinematics of hemiparetic subjects [Portuguese].**

**Author(s):** Guimarães RM, Pereira JS, Batista LA

**Citation:** Fisioterapia em Movimento, 01 July 2007, vol./is. 20/3(11-16), 01035150

**Publication Date:** 01 July 2007

**Abstract:** The purpose of this study is to identify the effect of spastic triceps surae muscle strength training in hemiparetic individuals improving walking, based on speed and cadence parameters. Fifteen spastic hemiparetic volunteers after Encefalic Vascular Accident (EVA), with at least one year of lesion, mean age of 30-65 years, were submitted to the soleus muscle strength training. The instruments used for this study were the adapted hand-held dynamometer for measuring the soleus muscle strength; the Modified Ashworth Scale (for spasticity assessment); quantitative gait assessment (velocity and cadence), with the measurements been taken before and after treatment. The supervisioned exercise program consisted of eight weeks (three times a week), for thirty minutes each day. The sessions were divided in periods of warming, stretching and strengthening. The results found were statistically significant with a value of $p<0.05$ for improvement soleus muscle strength of 58.29% on the affected side and 36.88% on the non-affected side; increase of velocity (13.51%) and cadence (23.13%). Based on this study one can concludes that the strength training exercises of the soleus muscle improve the gait of the hemiparetic individuals, showing that there is a correlation between the spastic soleus muscle and temporal gait factors, as velocity and cadence. This study suggests a regular practice of muscular strength training in spastic hemiparetic subjects as a great benefit treatment on neurological rehabilitation.

**Source:** CINAHL

**16. Effects of splinting on wrist contracture after stroke: a randomized controlled trial.**

**Author(s):** Lannin NA, Cusick A, McCluskey A, Herbert RD

**Citation:** Stroke (00392499), 01 January 2007, vol./is. 38/1(111-116), 00392499

**Publication Date:** 01 January 2007

**Abstract:** BACKGROUND AND PURPOSE: Splints are commonly applied to the wrist and hand to prevent and treat contracture after stroke. However, there have been few randomized trials of this intervention. We sought to determine whether wearing a hand splint, which positions the wrist in either a neutral or an extended position, reduces wrist contracture in adults with hemiplegia after stroke. METHODS: Sixty-three adults who had experienced a stroke within the preceding 8 weeks participated. They were randomized to either a control group (routine therapy) or 1 of 2 intervention groups (routine therapy plus splint in either a neutral or an extended wrist position). Splints were worn overnight for, on average, between 9 and 12 hours, for 4 weeks. The primary outcome, measured by a blinded assessor, was extensibility of the wrist and long finger flexor muscles (angle of wrist extension at a standardized torque). RESULTS: Neither splint appreciably increased extensibility of the wrist and long finger flexor muscles. After 4 weeks, the effect of neutral wrist splinting was to increase wrist extensibility by a mean of 1.4 degrees (95% CI, -5.4 degrees to 8.2 degrees), and splinting the wrist in extension reduced wrist extensibility by a mean of 1.3 degrees (95% CI, -4.9 degrees to 2.4 degrees) compared with the control condition. CONCLUSIONS: Splinting the wrist in either the neutral or extended wrist position for 4 weeks did not reduce wrist contracture after stroke. These findings suggest that the practice of routine wrist splinting soon after stroke should be discontinued.

**Source:** CINAHL
17. Evaluation of spastic muscle in stroke survivors using magnetic resonance imaging and resistance to passive motion.

Author(s): Ploutz-Snyder LL, Clark BC, Logan L, Turk M

Citation: Archives of Physical Medicine & Rehabilitation, 01 December 2006, vol./is. 87/12(1636-1642), 00039993

Publication Date: 01 December 2006

Abstract: Ploutz-Snyder LL, Clark BC, Logan L, Turk M. Evaluation of spastic muscle in stroke survivors using magnetic resonance imaging and resistance to passive motion. OBJECTIVE: To assess the feasibility of using magnetic resonance imaging (MRI) and resistance to passive movement to evaluate spastic muscle. DESIGN: T2-weighted MRI scans of the upper arm were obtained at rest and after the performance of upper-arm exercise. In addition, resistance to passive movement was measured subjectively (Modified Ashworth Scale [MAS]) and objectively by an isokinetic device while the arm was moved at varying speeds (stretch reflex torque). SETTING: Research laboratory. PARTICIPANTS: Six hemiplegic stroke survivors (single group) with spasticity in the elbow flexors and extensors. INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: Strength, stretch reflex torque, MAS, MRI-derived muscle cross-sectional area (CSA), and transverse relaxation time (T2). RESULTS: The affected sides exhibited spasticity (as assessed through MAS), with the extensors displaying a range of 0 to 3, and the flexors between 1 and 1+. The affected muscle groups were significantly weaker than the unaffected muscle groups (extensors: 61% less, flexors: 65% less; P/=.05). There was a tendency (P=.07; effect size, .48) for the resting T2 to be higher in affected versus unaffected biceps, but triceps values were similar (P>/=.05). Both muscle groups showed an increase in T2 after exercise (approximately 30%, P/=.05). For both muscle groups, the affected side had a greater stretch reflex torque, with the range of torque values being greater than the range of MAS scores. CONCLUSIONS: MRI and quantitative resistance to passive movement may be useful in the evaluation of spasticity. This is clinically relevant for the development and evaluation of antispasticity treatments. Copyright © 2006 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Source: CINAHL

18. Twelve weeks of nightly stretch does not reduce thumb web-space contractures in people with a neurological condition: a randomised controlled trial.

Author(s): Harvey L, de Jong I, Goehl G, Mardwedel S

Citation: Australian Journal of Physiotherapy, 01 December 2006, vol./is. 52/4(251-258), 00049514

Publication Date: 01 December 2006

Abstract: QUESTION: What is the effectiveness of 12 weeks of nightly stretch in reducing thumb web-space contracture in people with neurological conditions? DESIGN: Assessor-blinded, randomised controlled trial. PARTICIPANTS: Forty-four (one dropout)community-dwelling patients with a neurological condition (14 stroke, 7 traumatic brain injury, 23 spinal cord injury) who had uni or bilateral thumb web-space contractures (60 thumbs). INTERVENTION: The experimental thumbs were splinted into a stretched, abducted position each night for 12 weeks. The control thumbs were not splinted. OUTCOME MEASURES: Thumb web-space was measured as the carpometacarpal angle during the application of a 0.9 Nm abduction torque before and after intervention. RESULTS: The mean increase in thumb web-space after 12 weeks was 1 deg (95% CI, -1 to 2). CONCLUSION: Intensive stretch administered regularly over three months does not reduce thumb web-space contractures in neurological conditions.

Source: CINAHL
19. A randomized controlled pilot study to obtain the best estimate of the size of the effect of a thermoplastic resting splint on spasticity in the stroke-affected wrist and fingers.

Author(s): Sheehan JL, Winzeler-Merçay U, Mudie MH

Citation: Clinical Rehabilitation, 01 December 2006, vol./is. 20/12(1032-1037), 02692155

Publication Date: 01 December 2006

Abstract: OBJECTIVE: To obtain the best estimate of the size of the effect of a thermoplastic resting splint on spasticity in the stroke-affected upper limb. DESIGN: A randomized controlled intervention involving 14 adults affected by stroke, allocated to two groups. SETTING: Inpatient and outpatient rehabilitation departments. INTERVENTION: Following one week of baseline when neither group wore a splint, group 1 continued without a splint for week 2 and then wore a splint during week 3. Group 2 wore a splint during weeks 2 and 3. Both groups then wore a splint through weeks 4-7. MAIN MEASURES: A computerized torque apparatus was used to measure resistance at the wrist in newtons at every one-degree angle through the range of extension. Amount and rate of change in resistance was compared between the groups to obtain the best estimate of the size of the effect of splinting. RESULTS: Effect sizes were small and failed to reach the suggested smallest clinically worthwhile effect size for amount and rate of change in resistance in the short term. However, the average estimated size of the effect for rate of change with longer term splinting exceeded the smallest clinically worthwhile effect. CONCLUSIONS: These findings and the fact that confidence intervals overlapped the smallest clinically worthwhile size of the effect for amount and rate of change in both short and long term suggest that a study with a larger sample is warranted.

Source: CINAHL

Full Text: Available in fulltext at EBSCO Host

Available in print at Lincoln County Hospital Professional Library

20. Application of combined botulinum toxin type A and modified constraint-induced movement therapy for an individual with chronic upper-extremity spasticity after stroke.

Author(s): Sun S, Hsu C, Hwang C, Hsu P, Wang J, Yang C

Citation: Physical Therapy, 01 October 2006, vol./is. 86/10(1387-1397), 00319023

Publication Date: 01 October 2006

Abstract: BACKGROUND AND PURPOSE: Constraint-induced movement therapy (CIMT) is a promising intervention for retraining upper-extremity function after a stroke. The purpose of this case report is to describe the use of a combination of botulinum toxin type A (BtxA) and a modified CIMT program for a patient with severe spasticity who was unable to use his right upper extremity. CASE DESCRIPTION: The 52-year-old patient, who had a stroke 4 years ago, did not meet the minimum motor criteria for CIMT benefit. After receiving BtxA injections targeting the elbow, wrist, and finger flexors, he completed a 4-week program of modified CIMT followed by a 5-month home exercise program. OUTCOMES: The patient exhibited improvement in muscle tone (the velocity-dependent resistance to stretch that muscle exhibits) and in scores on several upper-extremity function tests (Modified Ashworth Scale, Motor Activity Log, Wolf Motor Function Test, Action Research Arm Test, and Fugl-Meyer Assessment of Motor Recovery). He also reported making much progress in the functional use of the involved upper extremity. DISCUSSION: In a patient with severe flexor spasticity and nonuse of the dominant upper extremity after a stroke, a combined treatment of BtxA and modified CIMT may have resulted in improved upper-extremity use.

Source: CINAHL

Full Text: Available in fulltext at Highwire Press

Author(s): Ada L, O'Dwyer N, O'Neill E

Citation: Disability & Rehabilitation, 15 July 2006, vol./is. 28/13-14(891-897), 09638288

Publication Date: 15 July 2006

Abstract: Purpose. Understanding the relationship between the motor impairments and their impact on physical activity will allow rehabilitation after stroke to be based on scientific principles. The aims of this study were to determine: (i) the relative contribution of weakness and spasticity to contracture, and (ii) the relative contribution of all three impairments to limitations in physical activity during the first 12 months after stroke.

Method. This longitudinal observational study charted the evolution of weakness (loss of maximal force), spasticity (stretch-evoked EMG) and contracture (loss of joint range) of the elbow flexors and limitations in upper limb activity (Motor Assessment Scale) for a year after stroke in 27 subjects who had suffered a first stroke. Spasticity was measured as abnormal reflex activity, weakness was measured as loss of maximum isometric torque, contracture was measured as the difference in range of motion between the affected and intact side, and limitations in physical activity were measured on a clinical scale.

Results. The major independent contributors to contracture were spasticity for the first four months after stroke (p = 0.0001 - 0.10) and weakness thereafter (p = 0.01 - 0.05). However, the major and only independent contributor to limitations in physical activity throughout the year was weakness (p = 0.0001 - 0.05).

Conclusions. For the first time, from a longitudinal study, the findings show that spasticity can cause contracture after stroke, consistent with the prevailing clinical view. However, weakness is the main contributor to activity limitations.

Source: CINAHL

Full Text: Available in fulltext at EBSCO Host

22. The effect of strengthening exercises on exaggerated muscle tonicity in chronic hemiparesis following stroke

Author(s): Akbari A., Karimi H.

Citation: Journal of Medical Sciences, May 2006, vol./is. 6/3(382-388), 1682-4474;1812-5727 (May 2006)

Publication Date: May 2006

Abstract: The purpose of this study was to determine quadriceps and gasterosoleous muscles tonicity problems in hemiparetic patients and the effects of strengthening exercises protocol in treatment of these impairments. In 2004, a clinical randomized trial was conducted in Tehran province, Iran. Thirty four-hemiparetic patients secondary to stroke aging 49.05+/-6.19 years participated in this trial. Patients were assigned randomly to either an experimental group or a control group and muscle strength (kg) were measured using hand held dynamometer and their muscle tone (ordinal) was graded on the Modified Ashworth Scale (MAS) before and after 12 sessions of intervention. The experimental group received functional, balance and strengthening exercises protocol. The control group received functional and balance exercises protocol. In experimental group measure of quadriceps and gastrosoleous tone decreased from 1.88+/-1.05 to 0.82+/-0.88 and 3.06+/-1.43 to 1.65+/-1.11, respectively (p<0.0001). Treatment was reduced gastrosoleous tone from 3.23+/-1.15 to 3+/-1 in the control group (p= 0.041). Tonicity of both muscles decreased in the experimental group compared to the control group (p<0.0001). Present results, in contrary with current opinions, support the effectiveness of lower limb muscle strength training to reduce the spasticity in addition to improving muscle strength in the chronic stage of stroke.

Source: EMBASE
23. Effects of changing wrist positions on finger flexor hypertonia in stroke survivors

Author(s): Li S., Kamper D.G., Rymer W.Z.

Citation: Muscle and Nerve, February 2006, vol./is. 33/2(183-190), 0148-639X;1097-4598

Publication Date: February 2006

Abstract: We sought to establish whether spastic hypertonia results from changes in intrinsic muscle properties or from altered stretch reflex properties. We hypothesized that finger flexor spastic hypertonia is primarily of neural origin, and that the dynamics of spastic muscle responses to stretch should therefore reflect the dynamics of muscle spindle receptor responses. In 12 stroke survivors, we recorded torque and electromyographic (EMG) responses of extrinsic finger flexors to constant-velocity rotation of the metacarpophalangeal (MCP) joints of the affected hand, over a range of initial muscle lengths. Stretch velocity was set to 6degrees, 50degrees, 150degrees, or 300degrees per second. Muscle length changes were imposed by changing wrist angle between 0degrees, 25degrees, and 50degrees of flexion. We found that reflex torque and EMG responses exhibited both velocity and length dependence, and there were significant interactions between velocity and length, replicating known characteristics of muscle spindle receptors. Our results support the hypothesis that finger flexor hypertonia is primarily of neural origin, and that it accurately reflects spindle receptor firing properties. Copyright 2005 Wiley Periodicals, Inc.

Source: EMBASE


Author(s): Pizzi A, Carlucci G, Falsini C, Verdesca S, Grippo A

Citation: Archives of Physical Medicine & Rehabilitation, 01 September 2005, vol./is. 86/9(1855-1859), 00039993

Publication Date: 01 September 2005

Abstract: OBJECTIVE: To evaluate clinical and neurophysiologic effects of 3-month reflex inhibitory splinting (RIS) for poststroke upper-limb spasticity. DESIGN: Pretest-posttest trial. SETTING: Outpatient rehabilitation center. PARTICIPANTS: Forty consecutive patients with hemiplegia and upper-limb spasticity after stroke that had occurred at least 4 months before. INTERVENTION: Patients wore an immobilizing hand splint custom-fitted in the functional position for at least 90 minutes daily for 3 months. MAIN OUTCOMES MEASURES: Patients underwent measurement of (1) spasticity at the elbow and wrist according to Modified Ashworth Scale; (2) passive range of motion (PROM) at the wrist and elbow; (3) pain at the shoulder, elbow, and wrist using a visual analog scale; (4) spasms; and (5) comfort and time of splint application. The instrumental measure of spasticity was the ratio between the maximum amplitude of the H-reflex and the maximum amplitude of the M response (Hmax/Mmax ratio). RESULTS: A significant improvement of wrist PROM (F=8.92, P=.001) with greater changes in extension than in flexion, and a reduction of elbow spasticity (F=5.39, P=.002), wrist pain (F=2.89, P=.04), and spasms (F=4.33, P=.008) were observed. The flexor carpi radialis Hmax/Mmax ratio decreased significantly (F=4.2, P=.007). RIS was well tolerated. CONCLUSIONS: RIS may be used as an integrative treatment of poststroke upper-limb spasticity. It can be used comfortably at home, in selected patients without functional hand movements, and in cases of poor response or tolerance to antispastic drugs. Copyright © 2005 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Source: CINAHL

25. Hand splints in rehabilitation.

Author(s): Paternostro-Sluga T, Stieger M

Citation: Critical Reviews in Physical & Rehabilitation Medicine, 01 November 2004, vol./is. 16/4(233-256), 08962960
Abstract: Hand splinting in rehabilitation has a long tradition and represents a well-established clinical treatment method. There are various therapeutic goals in hand splinting, from immobilization to functional improvement. Pathological conditions that frequently require splint treatment as a part of their rehabilitation management are rheumatoid arthritis (RA), osteoarthritis, tendinopathies, neurological diseases, and burn injuries. Moreover, splint treatment plays an important role in the aftercare of hand surgery. Scientific evidence is poor. There are a number of studies about RA demonstrating that working wrist splints do not have a detrimental effect on grip strength, but no beneficial effects can be statistically proven. The studies concerning splint treatment of carpal tunnel syndrome (CTS) report evidence for significant short-term relief from clinical symptoms. Following stroke there is insufficient evidence to support or refute the effectiveness of hand splinting. The lack of clinical evidence is in contrast to the widespread clinical use. It is our hope that this review article will encourage physicians and therapists to conduct randomized, controlled clinical trials to broaden the scope of available evidence of the efficacy of this treatment method.

Source: CINAHL

26. Electrophysiological and clinical assessment of a simple wrist-hand splint for patients with chronic spastic hemiparesis secondary to stroke

Author(s): Fujiwara T., Liu M., Hase K., Tanaka N., Hara Y.

Citation: Electromyography and Clinical Neurophysiology, October 2004, vol./is. 44/7(423-429), 0301-150X (Oct 2004)

Abstract: Purpose: The aim of this study is to assess the effect of a simple wrist-hand splint, made of mesh materials, on the spastic paretic hand. Methods: The participants were 15 patients with hemiparetic stroke. Time from stroke onset was over 120 days. We assessed integrated EMG of flexor digitorum sublimis (FDS), extensor indicis proprius (EIP), flexor carpi radialis (FCR), extensor carpi radialis (ECR), brachioradialis (BR) and triceps brachii (Tri) during active finger extension and shoulder flexion, without and with the wrist-hand splint. H reflexes and M waves were obtained on FCR by stimulating the median nerve, and H/M ratio was calculated. In another 5 patients who used the splint for 8 weeks, its long-term effects were assessed with clinical measures (active range of motion and muscle tone). Results: With the splint, muscle activities of FCR and BR were reduced during shoulder flexion, and those of FDS, FCR and BR decreased during finger. Attaching the splint also reduced the H/M ratio of FCR in five patients who had worn the wrist-hand splint during daytime for 8 weeks, significant increase in the active range of shoulder flexion and finger extension and decrease in muscle tone were demonstrated. The splint reduced co-activation of antagonists not only in wrist but also in finger and elbow muscles. Conclusion: It is suggested that the wrist-hand splint is beneficial to improve upper limb motor function in patients with spastic hemiparesis.

Source: EMBASE

27. Does spasticity result from hyperactive stretch reflexes? Preliminary findings from a stretch reflex characterization study.

Author(s): Salazar-Torres JD, Pandyan AD, Price CIM, Davidson RI, Barnes MP, Johnson GR

Citation: Disability & Rehabilitation, 17 June 2004, vol./is. 26/12(756-760), 09638288

Abstract: PURPOSE: To characterize the stretch reflex response of the biceps brachii in stroke patients with elbow spasticity (prior to or within 15 min of treatment with botulinum toxin) and non-impaired volunteers with the aim of quantifying the stretch reflex excitability and observe the differences between the groups. METHODS: A cross-sectional study. Stretch reflexes from the biceps brachii were elicited following a controlled elbow extension. The amplitude, latency, rise time and duration, calculated from surface EMG recordings from the biceps brachii, were used to characterize the stretch reflex response. RESULTS: Seventeen non-impaired and 14 stroke patients participated. The amplitude was significantly lower in stroke patients than in non-impaired volunteers (p<0.05). The latency
was significantly shorter in stroke patients than in non-impaired volunteers (p<0.05). There were no significant differences in rise time or duration (p>0.10). DISCUSSION: Reduction in the amplitude in stroke patients was unexpected suggesting the stretch reflex is not necessarily hyper-excitiable in people with clinically diagnosed spasticity. Latency differences suggest decreased presynaptic inhibition and/or increased motor neurone excitability can occur following a stroke. However, carry over effects from previous botulinum toxin treatment may have confounded amplitude measurements. Further work evaluating the excitability of the stretch reflex independent of Botulinum toxin and its contribution to resistance to passive stretching is being conducted.

Source: CINAHL

Full Text:
Available in fulltext at EBSCO Host

28. Change of stretch reflex threshold in spasticity: Effect of botulinum toxin injections

Author(s): Stampacchia G., Bradaschia E., Rossi B.

Citation: Archives Italiennes de Biologie, May 2004, vol./is. 142/3(265-273), 0003-9829 (May 2004)

Publication Date: May 2004

Abstract: Spasticity is a disorder of hypertonus associated with neurological diseases, characterized by a decrease in stretch reflex threshold. Stretch reflex threshold of wrist flexors has been recorded in subjects affected by forearm spasticity due to acute neurological lesions, occurred from one to sixty-one months before. In all the subjects a decreased stretch reflex threshold was recorded and a negative correlation between stretch reflex threshold and time of the disease resulted. In five subjects affected by mild spasticity the velocity stretch reflex threshold was tested one-three months after stroke and then six months later. In three cases a further decrease in stretch reflex threshold was recorded. Sixteen subjects affected by heavy forearm spasticity (quantified by Ashworth scale), were treated with Botulinum toxin injections to reduce spasticity. Fourteen of 16 subjects were responsive to the antispastic therapy: a decrease of at least 1 point in the Ashworth scale was detected after the treatment. In all the responsive cases an increase of stretch reflex threshold was recorded. The results confirm that the stretch reflex threshold is decreased in spastic muscles; it decreases progressively in time after the acute lesion. In addition, these results demonstrate that the decreased stretch reflex threshold can be reversed with Botulinum toxin injections. It is known that Botulinum toxin reduce the presynaptic release of Acetilcholine of neuromuscular synapses, but there are experimental evidences that it acts even on spindle's fibres, decreasing the sensitivity of intrafusal muscle fibres. This effect explains how Botulinum toxin increases the stretch reflex threshold in spastic muscles.

Source: EMBASE

29. Changes of reflex size in upper limbs using wrist splint in hemiplegic patients.

Author(s): Ushiba J, Masakado Y, Komune Y, Muraoka Y, Chino N, Tomita Y

Citation: Electromyography & Clinical Neurophysiology, April 2004, vol./is. 44/3(175-82), 0301-150X;0301-150X (2004 Apr-May)

Publication Date: April 2004

Abstract: We evaluated the effect of prolonged wrist extension on H reflex in the flexor carpi radialis (FCR) muscle and tendon jerk (T) reflex in the biceps brachii (BB) muscle of 17 chronic hemiplegic patients. H reflex of the FCR and T reflex of the BB were assessed every 5 minutes within 20 minutes during prolonged wrist extension and post-20 minutes after the extension. As a result, H reflex in the FCR was reduced by passive wrist stretch in 82% of the spastic limbs. The effect was larger in the higher spastic group. In 45% of the spastic limbs, T reflex in the BB also was reduced by passive wrist stretch. The inhibitory effects had a tendency to strengthen in accordance with the grade of muscle tone. We considered from these results, prolonged wrist extension generated inhibitory projections via probably group II afferents of the FCR in the homonym and in the transjoint in spastic
The aim of this study is to utilize the portable muscle tone measurement device and surface EMG for investigating the spasticity on the elbow flexors before BOTOX intervention. The reactive torque and reactive EMG (biceps brachii and triceps brachii muscles) of elbow joint induced at different stretching velocities (1/3, 1/2, 1 and 1.5 Hz) in limited range (-30 to +30 degrees, 90 degrees of elbow flexion was defined as zero degree) were recorded simultaneously in 2 weeks before BOTOX treatment. The velocity-dependent viscous component (Bomega) of elbow flexor and the EMG threshold defined as the angle at which the sustained EMG activity surpassed two folds of standard deviation of rest EMG prior to stretch were used for evaluating the severity of spasticity. In current study, we demonstrated that the viscoelastic parameter as well as EMG threshold could be used for quantifying the degree of spasticity. These parameters would be useful for quantifying the effects of BOTOX treatment in stroke patients.

Source: EMBASE

31. Is hand splinting effective for adults following stroke? A systematic review and methodological critique of published research.

Author(s): Lannin NA, Herbert RD

Citation: Clinical Rehabilitation, 01 December 2003, vol./is. 17/8(807-816), 02692155

Abstract: BACKGROUND: Upper limb hemiplegia after stroke is common and disabling. Hand splints are widely used to prevent contracture and reduce spasticity. OBJECTIVE: To assess the effectiveness of hand splinting on the hemiplegic upper extremity following stroke. SEARCH STRATEGY: A search was conducted of the Cochrane Central Register of Controlled Trials; the electronic databases MEDLINE, EMBASE, CINAHL, PEDro, SCI, SSCI; websites of professional associations; reference lists in trial reports and other relevant articles. SELECTION CRITERIA: Studies of the effect of upper extremity splinting on motor control, functional abilities, contracture, spasticity, or pain in the hand or wrist. DATA COLLECTION AND ANALYSIS: Validity of studies was assessed systematically and a content analysis was conducted of the methodologies used. Methodological quality of randomized trials was rated by two independent assessors using the PEDro scale. RESULTS: Nineteen studies were appraised for content. Of these, most (63%) were reports of case series. Four studies (21%) were randomized controlled trials. Methodological scores of trials ranged from 2 to 8 (maximum possible score 10). One trial of nominally 'medium' quality reported that inflatable arm splinting makes no difference to hand function (mean difference on Fugl-Meyer Assessment -0.12, 95% confidence interval (CI) -9.8 to 9.6). The remaining trials investigated effects of thermoplastic splints; one trial of 'high quality' reported no difference in contracture formation in the wrist and finger flexor muscles after wearing a hand splint which positioned the wrist in the traditional functional position for 12 hours each night for four weeks (mean difference in range of movement after four weeks was 1 degree, 95% CI -3.7 degrees to 6.1 degrees; power >80%). All remaining trials were of poor methodological quality. Limited research and lack of a no-splint control group in all trials to date limit the usefulness of these results. REVIEWER'S CONCLUSION: There is insufficient evidence to either support or refute the effectiveness of hand splinting for adults following stroke.

Source: CINAHL

Full Text:
Available in fulltext at EBSCO Host
32a. **Rehabilitation medicine: 3. Management of adult spasticity.**

**Author(s):** Satkunam LE

**Citation:** CMAJ Canadian Medical Association Journal, November 2003, vol./is. 169/11(1173-9), 0820-3946;0820-3946 (2003 Nov 25)

**Publication Date:** November 2003

**Abstract:** Spasticity refers to an abnormal, velocity-dependent (i.e., how fast the joint is moved through its range) increase in muscle tone resulting from interruption of the neural circuitry regulating the muscles and is a common complication of cerebral palsy, brain injuries, spinal cord injuries, multiple sclerosis and stroke. The muscle stretch reflex is thought to play an important role in spasticity generation. Spasticity can have a significant detrimental effect on daily functions, such as feeding, dressing, hygiene, bladder and bowel control, and mobility; patients' need for support can also influence the cost of care. Thus, managing these patients appropriately or referring them to those with expertise in this area is important. In this article, I review the pathophysiology of spasticity and the evaluation and management of adult patients with the condition. Two hypothetical cases are presented to illustrate the management of spasticity.

**Source:** MEDLINE

**Full Text:**
Available in fulltext at [EBSCO Host](#)

Available in fulltext at [National Library of Medicine](#)

32b. **Clinical evaluation of functional electrical therapy in acute hemiplegic subjects.**

**Author(s):** Popovic MB, Popovic DB, Sinkjær T, Stefanovic A, Schwirtlich L

**Citation:** Journal of Rehabilitation Research & Development, 01 September 2003, vol./is. 40/5(443-453), 07487711

**Publication Date:** 01 September 2003

**Abstract:** This paper describes a clinical randomized single-blinded study of the effects of Functional Electrical Therapy (FET) on the paretic arms of subjects with acute hemiplegia caused by strokes. FET is an exercise program that comprises voluntary arm movements and opening, closing, holding, and releasing of objects that are assisted by a neural prosthesis (electrical stimulation). FET consisted of a 30 min everyday exercise for 3 consecutive weeks in addition to conventional therapy. Twenty-eight acute hemiplegic subjects participated in a 6 mo study. The subjects were divided into lower functioning groups (LFGs) and higher functioning groups (HFGs) based on their capacity to voluntarily extend the wrist and fingers against the gravity, and were randomly assigned to controls or FET groups. The outcomes included the Upper Extremity Function Test, the coordination of elbow and shoulder movements, spasticity of key muscles of the paretic arm, and Reduced Upper Extremity Motor Activity Log. FET and control groups showed a recovery trend in all outcome measures. The gains in FET groups were much larger compared with the gains in control groups. The speed of recovery in FET groups was substantially faster compared with the recovery rate in control groups during the first 3 weeks (treatment). The LFG subjects showed less improvement than the HFG in both the FET and control groups.

**Source:** CINAHL

**Full Text:**
Available in fulltext at [EBSCO Host](#)

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33. **Systematic muscle building exercises in the rehabilitation of stroke patients**
**Author(s):** Badics E., Wittmann A., Rupp M., Stabauer B., Zifko U.A.

**Citation:** NeuroRehabilitation, 2002, vol./is. 17/3(211-214), 1053-8135 (2002)

**Publication Date:** 2002

**Abstract:** The effects of targeted strength training in patients with muscle weakness of central origin following cerebrovascular accidents has hardly been investigated to date. This prospective non-randomized study of 56 patients was designed to shed light on the effects of strength building exercises on muscle tone and on the gain in muscle strength achieved with them. All patients underwent a full residential neurologic rehabilitation program for 4 weeks, which included an exercise program for restoring the extensor strength of the legs and the supporting strength of the arms by leg and arm presses. Throughout the rehabilitation program muscle spasticity was evaluated clinically and maximal muscle strength on completion of the exercise program was compared to baseline. The extensor strength of the legs increased by 31.0 (+/- 26.7)% and the supporting strength of the upper limbs increased by 40.2 (+/- 15)%). The difference versus baseline was statistically significant for both variables. The extent of strength gain was positively correlated with the intensity and the number of exercising units. Muscle tone, which was abnormally high at baseline, did not further increase in any one case. The results of this study showed that targeted strength training significantly increased muscle power in patients with muscle weakness of central origin without any negative effects on spasticity.

**Source:** EMBASE

**Full Text:**
Available in fulltext at EBSCO Host

34. **Effect of muscle biomechanics on the quantification of spasticity.**

**Author(s):** Kamper DG, Schmit BD, Rymer WZ

**Citation:** Annals of Biomedical Engineering, December 2001, vol./is. 29/12(1122-34), 0090-6964;0090-6964 (2001 Dec)

**Publication Date:** December 2001

**Abstract:** The impact of muscle biomechanics on spasticity was assessed by comparison of the reflex responses of the elbow and metacarpophalangeal (MCP) flexor muscles in individuals with chronic spastic hemiplegia following stroke. Specifically, methods were developed to quantify reflex responses and to normalize these responses for comparison across different muscle groups. Stretch reflexes were elicited in the muscles of interest by constant velocity ramp-and-hold stretches at the corresponding joint. The muscles were initially passive, with the joint placed in a midrange position. Estimates of biomechanical parameters were used to convert measured reflex joint torque and joint angle into composite flexor muscle stress and stretch. We found that the stretch reflex response for the MCP muscle group had a 74% greater mean stiffness modulus than that for the elbow muscle group, and that the reflex threshold was initiated at an 80% shorter mean muscle stretch. However, we determined that initial normalized fiber length was significantly greater for the experiments involving the MCP muscles than for those involving the elbow muscles. Increasing the initial composite fiber length of the elbow flexors produced significant reduction of the reflex threshold (p<0.001), while decreasing the initial length of the MCP flexors significantly reduced their measured reflex stiffness (p<0.001). Thus, biomechanical parameters of muscle do appear to have an important effect on the stretch reflex in individuals with impairment following stroke, and this effect should be accounted for when attempting to quantify spasticity.

**Source:** MEDLINE

35. **Short-term effects of dynamic Lycra splints on upper limb in hemiplegic patients.**

**Author(s):** Gracies J, Marosszeky JE, Renton R, Sandanam J, Gandevia SC, Burke D

**Citation:** Archives of Physical Medicine & Rehabilitation, 01 December 2000, vol./is. 81/12(1547-1555), 00039993

**Publication Date:** 01 December 2000
Abstract: OBJECTIVE: To assess acceptability, effects on swelling, resting posture, spasticity, and active (AROM) and passive range of motion (PROM) of individually tailored upper limb Lycra garments, designed as dynamic splints to exert directional pull on certain limb segments, when worn for 3 hours by hemiplegic patients. DESIGN: Crossover trial. SETTING: Outpatient and inpatient rehabilitation center. PATIENTS: Convenience sample of 16 patients with hemiparesis and upper limb spasticity caused by a stroke more than 3 weeks before the study. INTERVENTIONS: Assessments performed at the start and end of a 3-hour period during a standard rehabilitation day when the patients were and were not wearing the garment. MAIN OUTCOME MEASURES: (1) Comfort assessed by questionnaire; (2) circumference of each limb segment; (3) resting posture at elbow and wrist; (4) spasticity at shoulder, elbow, and wrist using the Tardieu scale; and (5) AROM and PROM at shoulder, elbow, and wrist measured using a goniometer; (6) elbow proprioception using McCloskey's method; (7) visual neglect syndrome using the line bisection test. Differences between changes occurring with and without the garment were compared using Wilcoxon's signed rank test for ordinal variables (spasticity grading) and Student's t test for continuous variables (all other data). RESULTS: During 3 hours, garments worn on the arm by patients with hemiplegia (1) were comfortable, (2) improved wrist posture and reduced wrist and finger flexor spasticity, (3) reduced swelling in patients with swollen limbs (digit circumference decreased by 4%; p<.01), (4) improved PROM at shoulder (mean increase in range, 4.1 degrees +/- 13.0 degrees per shoulder movement; p<.01); and (5) impaired ability to flex fingers (range of voluntary flexion of digit III reduced from 107.3 degrees +/-79.6 degrees to 91.4 degrees +/-74.1 degrees; p<.05). CONCLUSION: Lycra garments, designed to produce continuous stretch of spastic muscles when worn for several hours each day, have rapid splinting and antispastic effects on wrist and fingers in patients with hemiplegia. These garments may help severely affected patients with major spasticity or painful swollen limbs. Copyright © 2000 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Source: CINAHL

36a. Quantitative measures of spasticity in post-stroke patients.
Author(s): Pisano F, Miscio G, Del Conte C, Pianca D, Candeloro E, Colombo R
Citation: Clinical Neurophysiology, June 2000, vol./is. 111/6(1015-22), 1388-2457;1388-2457 (2000 Jun)
Publication Date: June 2000

Abstract: OBJECTIVE: Quantitative evaluation of muscle tone in post-stroke patients; correlation of biomechanical indices with conventional clinical scales and neurophysiological measures; characterization of passive and neural components of muscle tone. METHODS: Mechanical stretches of the wrist flexor muscles of 53 post-stroke patients were imposed by means of a torque motor at constant speed. Patients were clinically studied using the Ashworth scale for spasticity and the Medical Research Council score for residual muscle strength. The neurophysiological measures were Hoffmann reflex latency, Hmax/Mmax ratio, stretch reflex threshold speed (SRTS), stretch reflex (SR) latency and area, passive (ISI) and total (TSI) stiffness indices. RESULTS: Hmax/Mmax ratio, SR area, ISI and TSI values were significantly higher in patients, while SRTS was significantly lower. TSI, SRTS and SR area were highly correlated to the Ashworth score. CONCLUSIONS: This EMG-biomechanical technique allows an objective evaluation of changes in muscle tone in post-stroke patients, providing easily measurable, quantitative indices of muscle stiffness. The linear distribution of these measures is particularly indicated for monitoring changes induced by treatment. The apparatus seems suitable to characterize neural stiffness, while difficulties were found in isolating the passive components, because of the occurrence of tonic EMG activity in most spastic patients.

Source: MEDLINE

36b. Time-course analysis of stretch reflexes in hemiparetic subjects using an on-line spasticity measurement system
Abstract: Spasticity after a stroke is usually assessed in a score form by subjectively determining the resistance of a joint to an externally imposed passive movement. This work presents a spasticity measurement system for on-line quantifying the stretch reflex of paretic limbs. Four different constant stretch velocities in a ramp-and-hold mode are used to elicit the stretch reflex of the elbow joint in spastic subjects. The subjects are tested at supine position with the upper limb stretched towards the ground, in contrast with the horizontally stretched movement used in other studies. By subtracting the baseline torque, reflex torque measured at a selected low stretch velocity of 5 deg/sec, the influence of gravity torque and inertial in vertical stretching mode can be minimized. The averaged speed-dependent reflex torque (ASRT), defined as the measured torque deviated from the baseline torque, is used for quantifying the spastic hypertonia. Four subjects having incurred cerebrovascular accident (CVA) are recruited for time-course study in which the measurements are taken at 72 hours, one week, one month, three months, and six months after onset of stroke. During the development of spasticity, the changes of ASRT and velocity sensitivity of ASRT of the involved and the intact elbow joints are discussed.

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Source: EMBASE

37. An electromyographic kinetic model for passive stretch of hypertonic elbow flexors.

Author(s): Harben AM

Citation: , 01 January 2000, vol./is. /(0-200),

Abstract: The purpose of this research was to model torque of spastic flexors of the elbow undergoing a ramp stretch, by developing a relationship between the EMG response and muscle kinematics. Ten hemiparetic subjects underwent constant velocity eccentric stretching of the elbow flexors by a servo-controlled torque motor. Ramp stretches were performed over 0.9 radians on each subject at two speeds, between 0.5 and 1.9 radians/second. Surface EMG activities from the elbow flexor muscles, torque from the limb, and angular position were sampled at 1000 Hz and recorded. At each angular velocity, three consecutive stretches were performed per session, for 10 to 16 sessions. Six of the 10 subjects, with the greater torque and EMG responses, were selected for modeling. In the 4 other subjects, torque and EMG responses were small or absent. Spasticity was due to stroke in all six subjects. The EMG-Kinetic model utilized processed EMG signals as modulators of the spring coefficients of the three primary elbow flexors. EMG signals were rectified, low pass filtered, and time shifted. The forearm muscles were modeled as EMG modulated linear springs with moment arms about the elbow joint. Other models used for comparison included torsional and extensional spring (simple kinetic) models, an EMG model, and an EMG-moment arm model. Stiffness coefficients and stiffness functions were calculated for the biceps, brachialis, and brachioradialis muscles; allowing estimation of their relative contributions to spastic behavior in individual subjects. Compared to other common kinetic and EMG models used to estimate muscle stiffness over a large ramp stretch, the EMG-Kinetic model produced statistically better fits, with p values of <=0.05, and a mean Pearson's correlation coefficient of 0.91 for all trials of all subjects.

Source: CINAHL

38. Botulinum toxin A in the treatment of spasticity after stroke

Author(s): Hesse S.

Citation: Aktuelle Neurologie, 2000, vol./is. 27/9(412-417), 0302-4350 (2000)

Abstract: The treatment of focal spasticity with Botulinum toxin gains more and more acceptance in the neurological rehabilitation after stroke. The present review describes
studies on the treatment of upper limb flexor spasticity and of an equinovarus foot deformity. Furthermore, technical aspects to increase the effectiveness of the costly neurolytic treatment are discussed. The encouragement to actively use the treated extremity, the electrical stimulation and/or a tonic stretch following the injection as well as a high dilution have proven effective in this regard.

Source: EMBASE

39. Quantitative features of the stretch response of extrinsic finger muscles in hemiparetic stroke

Author(s): Kamper D.G., Rymer W.Z.

Citation: Muscle and Nerve, 2000, vol./is. 23/6(954-961), 0148-639X (2000)

Publication Date: 2000

Abstract: Despite its potential importance in hand dysfunction, spasticity in the finger muscles following stroke has not been well described. To explore this area, we assessed the role of finger flexor spasticity, along with that of passive mechanical forces, in resisting finger movement in 13 chronic stroke subjects. Subjects were tested with a device that stretched the extrinsic finger muscles through imposed rotation of the metacarpophalangeal (MCP) joints. Both maintained and constant-velocity stretches were imposed. For the constant-velocity stretches, eight of the 13 stroke subjects exhibited strong stretch reflexes, as determined by electromyography and net work. The net work of this reflex response, calculated from the integral of the torque- angle plots, increased proportionally with increasing velocity, indicating a contribution from flexor muscle spasticity. Conversely, nine of the 13 stroke subjects did not possess distinctly greater passive, mechanical resistance to MCP rotation than control subjects. While extensor spasticity was not observed, stretch of the extrinsic finger flexor also produced some reflex activity in the finger extensors concomitant with reflex excitation of the flexor. These findings suggest that resistance to muscle stretching following stroke is mediated primarily by neurological rather than biomechanical disturbances, although changes in muscle fiber length may exaggerate the resistance. (C) 2000 John Wiley and Sons, Inc.

Source: EMBASE

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