Research Update: Support in the Literature for TheraTogs™ Elasticized Orthotic Garment and Strapping Systems

Effectiveness of TheraTogs Applications:

- Siracusa C, Taynor M, Geletka B, Overby A. (2005) Effectiveness of a biomechanical intervention in children with spastic diplegia. **Pediatric Physical Therapy** 17(1): 83-84

General Support from the Sciences: Neuromotor Reeducation / Purposeful Practice / Repetition / Kinesiology

- Abel MF, Damiano DL, Blanco JS, et al. 2003. Relationships among musculoskeletal impairments and functional health status in ambulatory cerebral palsy. *J Pediatr Orthop.* 23(4): 535-541. [129 ambulatory children and adolescents participated in a prospective evaluation that consisted of LE passive motion and spasticity examination, 3-D gait temporal-spatial and kinematic analysis, and acquisition of GMFM and PODCI data. Conclusion: caution should be exercised when anticipating functional change through the treatment of isolated impairment and that addressing multiple impairments may be needed to produce appreciable effects.]
- Adolph KE http://www.psych.nyu.edu/adolph/students.shtml
- Adolph KE, Vereijken B, Shrout PE. 2003. What changes in infant walking and why. *Child Dev*. 74(2):475-97.
- Adolph KE. 1997. Learning in the development of infant locomotion. *Monogr Soc Res Child De*v. 62(3):I-VI, 1-158.
- Arnheim DD. (1989) Taping and bandaging. In: *Modern Principles of Athletic Training*, 314-343.. St. Louis, MO, Los Altos, CA, Toronto, and Boston, MA: Times/Mirror/Mosby College Publishing. [Author uses the old white tape and several layers over joints. Good ideas re taping hip and hand/thumb.]
- Austin K, Gwynn-Brett K, Marshall S. (1994) *Illustrated Guide To Taping Techniques.* (ISBN 0 7234 1635 4) London: Wolfe c/o Mosby - Year Book Europe Ltd., Lynton House 7-12 Tavistock Sq., London, WCIH 9LB.
- Bedotto RA. 2006. Biomechanical assessment and treatment in lower extremity prosthetics and orthotics: a clinical perspective. Phys Med Rehabil Clin N Am. 17(1): 203-243.

  [Biomechanical treatment is like a jigsaw puzzle with two complex counterparts having many pieces. The physical and mechanical components are equally important and cannot be separated from each other. The patient with a prosthesis or an orthosis represents a biomechanical system; total treatment is essential. All of the pieces to the puzzle must be used to complete the picture. Given the present structure of the educational system, there is a separation of disciplines necessary to provide one truly biomechanical treatment. Physical therapists are educated in the bio aspect of treatment, whereas prosthetists/orthotists are educated in the mechanical aspect. Biomechanical treatment requires the direct interaction and integration of the two disciplines. Physical therapists and prosthetists/orthotists need each other. One without the other can provide only half of the treatment necessary for optimal outcomes. The patient needs both. Physical therapists need to become more familiar with

mechanical treatment and learn how to integrate this into their physical treatment program. Prosthetists/orthotists must become more familiar with the importance of physical treatment and the internal corrective forces necessary for efficient ambulation. The traditional label of orthotics and prosthetics and related ***technology as products*** *must be replaced with* ***biomechanical treatment that includes orthotics and prosthetics services****.*

Professionals working with each other is a positive step, but they need to be working together as a team toward a common goal. They need to be in the same place at the same time and work together consistently to provide total treatment. This is more than a multidisciplinary approach. It is one treatment. In this way, each benefits the other as they teach and learn simultaneously. At present, this teaching and learning can be done only on an individual basis. It is the author's hope that experienced prosthetists/orthotists and physical therapists reading this article will see the need to combine their efforts to provide truly biomechanical treatment. By working together, they can expand their present knowledge and skills. In this way, treatment and outcomes can improve and serve as the guiding force for a new generation of rehabilitation specialists. This process can be expedited through the educational system by offering advanced clinical degrees specializing in biomechanical treatment specifically designed for clinical practice rather than research, administrative, or academic positions. For this idea to become reality, educational institutions representing the physical and mechanical aspects of biomechanical treatment also must work together; this would expedite the learning curve so that it would not take so long to put the pieces of the puzzle together.]

- Beynnon BD, Renstrom PA. (1991) The effect of bracing and taping in sports. Annals Chir. Gynaecol. 80(2): 230-238.
- Birrer RB, Poole B. (1994) Taping of sports injuries: Review of a basic skill. J Musculoskeletal Med. 11(6): 56.
- Edin BB, Vallbo AB. 1988. Stretch sensitization of human muscle spindles. J Physiol. 400: 101-111. [67 afferents from the finger extensor muscles were consecutively recorded by microneurography. The units were classified as primary (I) or secondary (II) muscle spindle afferents or Golgi tendon organ (GTO) afferents on the basis of their responses to ramp-and-hold stretches, sinusoidals superimposed on ramp-and-hold stretches, maximal twitch contractions and isometric contractions and relaxations. The muscle was repeatedly stretched and then either kept short or long for a few seconds followed by a slow ramp stretch. The responses of the muscle afferents to the slow stretch were compared under the two conditions. 30 of 38 I spindle afferents, 4 of 11 of the II afferents, and none of the 18 GTOs showed an enhanced response to the slow ramp when the muscle had been kept short compared to the response when the muscle had been kept long. Conclusion: Stretch sensitization does occur in human muscle spindles and, when present, constitutes firm evidence of the afferent originating from a muscle spindle rather than a GTO.
- Fisher B. 1987. Effect of trunk control and alignment on limb function. *J Head Trauma Rehabil*. 2(2): 72.
- Ge W, Long CR, Pickar JG. 2005. Vertebral position alters paraspinal muscle spindle responsiveness in the feline spine: effect of positioning duration. *J Physiol.* 569(Pt 2): 655-665. *[Proprioceptive information from paraspinal tissues including muscle contributes to neuromuscular control of the vertebral column. We investigated whether the history of a vertebra's position can affect signalling from paraspinal muscle spindles. Single unit recordings were obtained from muscle spindle afferents in the L6 dorsal roots of 30 anaesthetized cats. The L6 vertebra was controlled using a displacement-controlled feedback motor and was held in each of three different conditioning positions for durations of 0, 2, 4, 6 and 8 s. Conditioning positions (1.0-2.2 mm dorsal and ventral relative to an intermediate position) were based upon the displacement that loaded the L6 vertebra to 50-60% of the cat's body weight. Following conditioning positions that stretched (hold-long) and shortened (hold-short) the spindle, the vertebra was repositioned identically and muscle spindle discharge at rest and to movement was compared with conditioning at the intermediate position.*

Hold-short conditioning augmented mean resting spindle discharge; however, the duration of hold-short did not significantly affect this increase. The increase was maintained at the beginning of vertebral movement but quickly returned to baseline. Conversely, hold-long conditioning significantly diminished mean resting spindle discharge. The relationship between conditioning duration and the diminished resting discharge could be described by a quadratic revealing that the effects of positioning history were fully developed within 2 s of conditioning. In addition, 2 s or greater of hold-long conditioning significantly diminished spindle discharge to vertebral movement. These effects of vertebral positioning history may be a mechanism whereby spinal biomechanics interacts with the spine's proprioceptive system to produce acute effects on neuromuscular control of the vertebral column.

- Howle, JM (2002) Neuro-Developmental Treatment Approach: Theoretical Foundations and Principles of Clinical Practice. www.ndta.org .
- Kaze K., Hashimoto T. (1996) *Kinesio taping perfect manual: amazing taping therapy to eliminate pain and muscle disorders.* Kinesio Taping Association (Available through Progressive GaitWays, LLC.)
- Kaze K. *Illustrated Kinesio taping.* Kinesio Taping Association. (Available at Medco Sports Medicine: www.medco-athletics.com - 800-556-3326.)
- Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. 2005. *Muscles: Testing and Function with Posture and Pain, 5th edition*. Baltimore MD: Williams and Wilkins.
- Ketelaar M, Vermeer A, Hart H, van Petegem-van Beek E, Helders PJ. 2001. Effects of a functional therapy program on motor abilities of children with cerebral palsy. *Phys Ther.* 81(9): 1534-45.
- Kolban M. (1999) [Variability of the femoral head and neck antetorsion angle in ultrasonographic measurements of healthy children and in selected diseases with hip disorders treated surgically] *Ann Acad Med Stetin.* Suppl 51: 1-99. [Article in Polish]

  [An increase in antetorsion was observed in 56 joints (77%) in a group of 38 children with spastic CP subjected to surgery. Mean angle of antetorsion was 37^{o} (SD +/- 11). The angle returned to its pre-operative values within 2-3 years from surgery. In the group of 25 children with Perthes disease, increased antetorsion was found in 11 (44%) joints subjected to surgery and in 8 (32%) normal joints. The angle changed during the observation period, confirming the opinion that the increase is a secondary event in this disease. The angle was much greater than normal for age in the group of 21 children with congenital hip dysplasia. Basing on the results of surgery it is concluded that corrective osteotomy of femoral proximal end in cases of increased antetorsion and valgity of femoral neck is not a sufficient procedure to prevent the angle from reverting to pre-operative values and should be supplemented by osteotomy of the pelvis. Furthermore, ***ultrasonography has emerged as the best method currently available for measurement of femoral head and neck antetorsion.*** *The correlation coefficient for USG vs. direct (intraoperative) measurement was 0.9 in all groups, reaching 0.93 in the spastic CP group, in which contractures and limited mobility are responsible for very low coefficients in the case of other methods. The use of USG for assessment of femoral antetorsion has revealed, particularly after longer observation periods, that the angle in the apparently normal contralateral extremity exceeded values normal for age.]*
- Maruyama Y. (1995) Reusable taping system. *National Technical Report* 41(3): 25.
- Meuller® Basic principles of athletic taping. (Available at Medco Sports Medicine: www.medco-athletics.com - 800-556-3326.)
- Patel N, Smith CE, Pinchak AC, Hancock DE. (1994) The influence of tape type and of skin preparation on the force required to dislodge angiocatheters. *Can J Anesthesiol*. 41(8): 73741 (August)

- Poole JL. 1991. Application of motor learning principles in occupational therapy. *Am J Occup Ther.* 45(6): 531-537. Review
- Pincivero DM, Bachmeier B, Coelho AJ. (2001) The effects of joint angle and reliability on knee proprioception. *Med Sci Sports Exerc* 33(10):1708-1712.

  The detection of passive knee movement, and the subsequent voluntary response, may be dependent on joint angle. Authors suggest a PPC assessment method that should enhance test-retest reliability.
- Sahrmann SA. (2002) *Diagnosis and treatment of movement impairment syndromes*. St. Louis, MO: Mosby.

  [***BEVERLY CUSICK:*** *Essential. Tough reading at times, but certainly worth the wait!!]*
- Sanders JE, Goldstein BS, Leotta DF. (1995) Skin breakdown in response to mechanical stress: adaptation rather than breakdown - a review of the literature. *J Rehabil Res Dev*. 32(3): 214-226. *[**BEVERLY CUSICK:** Good review of skin tissue adaptability and physiology under loads. Applies to orthotic (compression and shear) more than taping (tensile loading) interventions. Excellent list of references.]*
- Manual of Athletic Taping. Published by the Sports Medical Council of British Columbia. (Available at Medco Sports Medicine: www.medco-athletics.com - 800-556-3326.)
- Thomas SS, Moore C, Kelp-Lelane C, Norris C (1996) Simulated gait patterns: the resulting effects on gait parameters, dynamic electromyography, joint moments, and physiological cost index. *Gait Posture* 4: 100-107. *[Authors altered gait function and all other variables by taping the ankle into equinus and setting the knee in flexion on nondisabled subjects. EMG patterns were similar to those reported for children with CP.]*
- Thornton JL, Webster JA. (1996) The "tape cast" functional taping for the injured athlete. *J Athletic Training* 31(2): 179.
- **van der Heide JC**, **Hadders-Algra M**. 2005. **Postural muscle dyscoordination in children with cerebral palsy.** *Neural Plast.* 12(2-3): 197-203; discussion 263-72. *[Until now, 3 children with CP functioning at GMFCS level V have been documented. The children totally or partially lacked direction specificity in their postural adjustments and could not sit independently for >3 seconds. Some children functioning at GMFCS level IV have intact direction-specific adjustments, whereas others have problems in generating consistently direction-specific adjustments. Children at GMFCS levels I to III have an intact basic level of control but have difficulties in fine-tuning the degree of postural muscle contraction to the task-specific conditions, a dysfunction more prominently present in children with bilateral spastic CP than in children with spastic hemiplegia. The problems in the adaptation of the degree of muscle contraction might be the reason that children with CP, more often than typically developing children, show an excess of antagonistic coactivation during difficult balancing tasks and a preference for cranial-caudal recruitment during reaching.]*
- Woollacott MH, Shumway-Cook A. 2005. Postural dysfunction during standing and walking in children with cerebral palsy: what are the underlying problems and what new therapies might improve balance?
  Neural Plast. 12(2-3): 211-219; discussion 263-72. Review. *[The efficiency of balance recovery can be improved in children with CP, indicated by both a reduction in the total center of pressure path used during balance recovery and in the time to restabilize balance after training. Changes in muscle response characteristics contributing to improved recovery include reductions in time of contraction onset, improved muscle response organization, and reduced co-contraction of agonists/antagonists. Clinical implications include the suggestion that improvement in the ability to recover balance is possible in school age children with CP.]*
- Woods E. (1998) Jenny McConnell: The woman behind the technique. *PT Magazine* - April issue:

32-39.

- Winstein CJ, Rose DK, Tan SM, et al. (2004) A randomized controlled comparison of upper-extremity rehabilitation strategies in acute stroke: A pilot study of immediate and long-term outcomes. *Arch Phys Med Rehabil.* 85(4): 620-8.
- Wright K, Whitehill W. Cramer® *Comprehensive manual of taping and wrapping techniques*, 2nd edition. (Available at Medco Sports Medicine, www.medco-athletics.com / 800-556-3326.)

Trunk / Shoulder/ UE / Elasticized Garments and Joint Supports

- Aubin CE, Labelle H, Ruszkowski A, et al. 1999. Variability of strap tension in brace treatment for adolescent idiopathic scoliosis. *Spine.* 24(4): 349-354. *[A mechanical evaluation of brace strap tensions to document their variability in different patient positions and to assess their biomechanical effectiveness. OBJECTIVES: To measure the strap tensions at which adolescents with scoliosis are wearing their braces and to determine the variations in strap tension in different patient positions. SUMMARY OF BACKGROUND DATA: The biomechanical action of thoracolumbosacral orthoses is still not well understood, and there is no standardized strap tension at which the brace should be fastened to obtain optimal results. METHODS: This study was conducted in 34 adolescents with idiopathic scoliosis wearing thoracolumbosacral orthoses. Brace straps were instrumented with load cells and tightened at four tensions (the ones prescribed by their treating physician and three standardized values: 20, 40, and 60 N). In each case, the tension was recorded while the patients assumed nine positions corresponding to normal daily tasks. The variability of strap tension was evaluated by comparing the changes from the original standing position. RESULTS: The prescribed tensions measured in thoracic and pelvic straps were markedly variable. The greatest changes in tension occurred when the patients were lying down. Relaxation of strap tension was found when the patients returned to the standing position after having completed the tasks. CONCLUSIONS: If strap tension affects the biomechanical actions of the brace, these results indicate that regular brace strap tension adjustments are needed and raise questions about the efficacy of nighttime bracing to correct spinal deformities.*
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- Beynnon BD, Good L, Risberg MA. (2002) The effect of bracing on proprioception of knees with anterior cruciate ligament injury*. J Orthop Sports Phys Ther* 32(1):11-15. [After ACL injury, application of an elastic bandage or neoprene sleeve improved joint position sense and showed no effect on recovery of position sense after 2 years of wear.]
- Birmingham TB, Kramer JF, Inglis JT, et al. (1998) Effect of a neoprene sleeve on knee joint position sense during sitting open kinetic chain and supine closed kinetic chain tests. *Am J Sports Med* 26(4): 562-566. ["Although the sleeve effects were small…, 72% of subjects felt the sleeve improved their overall test performance."]
- Birrer RB, Poole B. (1996) Athletic taping, part 4: the shoulder and elbow*. J Musculoskel Med* 13(1): 52.
- Blair, E., J. Ballantyne, S. Horsman, P. Chauvel (1995) A study of a dynamic proximal stability splint in the management of children with cerebral palsy. *Dev Med Child Neurol* 37:544-554. [The Upsuit is a custom-made, Lycra trunk suit. Significant effect on postural stability and UE movement, and carry-over noted. Advocated particularly for athetoid and dystonic subjects. Limit wear to 6 hours/day to avoid dependence on it.]
- Bower E, McLellan DL. 1992. Effect of increased exposure to physiotherapy on skill acquisition of children with cerebral palsy. *Dev Med Child Neurol. 1*992 Jan;34(1):25-39.
- Bravard S, Diehl D, Hogan A, Moeding J, Wallace M. (1997) The effectiveness of inhibitory taping of the upper trapezius muscle during a functional reach as determined by electromyography*. Phys Ther* 77(5): s-29. [Abstract] [Authors found reduced EMG output for both shoulder shrug and

shoulder forward flexion in all 37 PT student subjects.]

- Cholewicki J, Juluru K, Radebold A, Panjabi MM, McGill SM. 1999. Lumbar spine stability can be augmented with an abdominal belt and/or increased intra-abdominal pressure. *Eur Spine J.* 1999;8(5):388-95.
- Deivert RG. (1994) Functional thumb taping procedure. *J Athletic Training* 29(4): 357.
- Diamond W. (1995) Upper extremity: shoulder. In Myers, R.S.: *Saunders Manual of Physical Therapy Practice*, 789-839. Philadelphia, PA: W.B. Saunders Co. [Shows taping for shoulder dislocation, p. 823.]
- Gericke T. Postural management for children with cerebral palsy: consensus statement. Dev Med Child Neurol. 2006 Apr;48(4):244. A Mac Keith Multidisciplinary Meeting formulated the following consensus statement concerning postural management for children with cerebral palsy (CP) based on evidence from clinical experience and scientific literature:Definition: A postural management programme is a planned approach encompassing all activities and interventions which impact on an individual's posture and function. Programmes are tailored specifically for each child and may include special seating, night-time support, standing supports, active exercise, orthotics, surgical interventions, and individual therapy sessions.
- Gracies JM, Marosszeky JE, Renton R, Sandanam J, Gandevia SC, Burke D.Short-term effects of dynamic lycra splints on upper limb in hemiplegic patients. *Arch Phys Med Rehabil*. 2000 Dec;81(12):1547-55.
- Gracies JM, Fitzpatrick R, Wilson L, et al. (1997) Related Articles, Lycra garments designed for patients with upper limb spasticity: mechanical effects in normal subjects. *Arch Phys Med Rehabil* 78(10):1066-71.
- Host HH. (1995) Scapular taping in the treatment of anterior shoulder impingement. *Phys Ther* 75(9): 803-812.
- Hylton N, Allen C. (1997) The development and use of SPIO Lycra compression bracing in children with neuromotor deficits. *Pediatr Rehabil.* 1(2): 109-116. [Stabilizing Pressure Input Orthosis, developed by a parent, Cheryl Allen and Nancy Hylton,PT, is a development off the BENIK trunk supports, using lighter and cooler layers of Lycra. Spio reportedly evolved in parallel with the Australian, Ballantyne's Upsuit. Review article with photos of cases and suggested protocols, in combination with "DAFOs".]
- Jerosh J, Schmidt K, Prymka M. (1997) Proprioceptive capacities of patients with retropatellar knee pain with special reference to effectiveness of an elastic knee bandage. *Unfallchirurg* 100(9): 719-723. [In German] [The bandage improved proprioception in the injured knees.]
- Johnson MP, McClure PW, Karduna AR. (2001) New method to assess scapular upward rotation in subjects with shoulder pathology. *J Orthop SportsPhys Ther* 31(2):81-89. [Authors used a modified digital inclinometer, and found good to excellent validity.]
- Kluzik J, Fetters L, Coryell J. 1990. Quantification of control: a preliminary study of effects of neurodevelopmental treatment on reaching in children with spastic cerebral palsy. *Phys Ther.* 70(2):65-76; discussion 76-8.
- Knox, V. (2003). The use of lycra garments in children with cerebral palsy: a report of a descriptive clinical trial. *British Journal of Occupational Therapy, 66*(2), 71-77.
- Marin R. (1998) Scapular winger's brace: A case series on the management of long thoracic nerve palsy. Arch Phys Med Rehabil 79: 1226-1230.
- Marcus RL, Sands WA, Nicholson DE. (2001) The effects of compression garments on movement function in motor impaired children. *Poster presentation – Gait and Clinical Movement Analysis Society – Annual Meeting*, Sacramento, CA. April. *[Author investigated claims made by Blair et al (1995) and Hylton et al (1997) by using gait analysis to detect effects of wearing compression*

garments on kinematics and kinetics of gait and of single limb stance phase. No significant effect was reported. So I invited Robin to consider repeating the study using elasticized strapping in addition to compression garments to alter gait kinematics.]

- Morin L, Bravo G. (1997) Strapping the hemiplegic shoulder: a radiographic evaluation of its efficacy to reduce subluxation. Physiotherapy Canada Spring: 103-112. [Authors compared typical sling with elastic adhesive taping for 15 patients with shoulder subluxation, 5 days each, and then combined them. The two supports combined were most effective.]
- Nicholson JH, Morton RE, Attfield S, Rennie D. (2001) Assessment of upper limb function and movement in children with cerebral palsy wearing lycra garments. *Dev Med Child Neurol*. 43: 384-391. [Functional gains from increased proximal stability were often outweighed by inconvenience of donning and doffing and loss of independence.]
- Nuzzo RM. (1980) Dynamic bracing: elastics for patients with cerebral palsy. muscular dystrophy, and myelodysplasia. *Clinical Orthopaedics and Related Research* 148: 263-270.
- Paleg G, Hubbard S, Brite E, O'Donnell K. (1999) Dynamic Trunk Splints and Hypotonia*. Phys Ther Case Rep* 2(3):122-124. (May)
- Paleg G. (1997) Improving function with dynamic trunk splints. *Advance for Phys Ther* 8(48):34. December 1 issue. [Author describes Second Skin's "Upsuit" and BENIK's neoprene splint.]
- Perlau R, Frank C, Fick G. (1995) The effect of elastic bandages on human knee proprioception in the uninjured population. *Am J Sports Med.* 23(2):251-252. [Improvement was significant for the duration or wear, and was related to pre-wrapping knee angle test performance.]
- Rennie DJ, Attfield SF, Morton RE, Polak FJ, Nicholson J. (2000) Related Articles, An evaluation of lycra garments in the lower limb using 3-D gait analysis and functional assessment (PEDI). *Gait Posture* 12(1):1-6.
- Rettig AC, Stube AC, Shelbourne KD. (1997) Effects of finger and wrist taping on grip strength. *Amer J Sports Med*. 25(1): 96. [No improvement with either or both parts taped the way the authors taped them.]
- Sainburg RL, Poizner H, Ghez C. (1993) Loss of proprioception produces deficits in interjoint coordination. *J Neurophysiol.* 70(5): 2136-2147.
- Sauers EL. Effectiveness of rehabilitation for patients with subacromial impingement syndrome. J Athl Train. 2005 Jul;40(3):221-3.
- Shamus JL, Shamus EC. (1997) A taping technique for the treatment of acromioclavicular joint sprains: a case study. *J Orthop Sports Phys Ther* 25(6): 390-394.
- Snijders CJ, Hermans PF, Niesing R, Spoor CW, Stoeckart R. 2004. The influence of slouching and lumbar support on iliolumbar ligaments, intervertebral discs and sacroiliac joints. Clin Biomech (Bristol, Avon). 19(4): 323-329. CONCLUSIONS: Backward rotation of the pelvis combined with flexion of the spine, i.e. slouching, results in backward rotation of the sacrum with respect to the ilium, dorsal widening of the intervertebral disc L5-S1 and strain on the iliolumbar ligaments when protection from back muscles against lumbar flexion is absent. Lumbar backrest support almost eliminates lumbosacral and sacroiliac movement. RELEVANCE: Understanding why the iliolumbar ligaments are loaded in slouching contributes to the understanding of the biomechanics of low back pain in everyday situations with small or negligible compressive spinal load. The results recommend lumbar support: backrests with free shoulder space.
- Taylor BA, Ellis E, Haran D. 1995. The reliability of measurement of postural alignment to assess muscle tone change. *Physiotherapy* 81(8): 485-490.
- van der Heide JC, Begeer C, Fock JM, et al. 2004. Postural control during reaching in preterm children with cerebral palsy. *Dev Med Child Neurol.* 46(4):253-6

- Wang S, Hughes K, Olsen S, Hanten W. (1997) The effect of the McConnell shoulder taping technique in normal subjects: an electromyographic study. *Phys Ther.* 77(5): S-41. [Abstract} [29 subjects with no pathology, mean age 28. Taping was used to reposition the humeral head (?). Authors detected no changes in EMG output with and without taping, and considered that the lack of pathology might be a factor. Perhaps the taping technique is another factor?]

Hip and LEs

- Ahl LE, Johansson E, Granat T, Carlberg EB. 2005. Functional therapy for children with cerebral palsy: an ecological approach. *Dev Med Child Neurol.* 47(9): 613-9.
- Baquie P. 2002. Taping. General principles. *Aust Fam Physician*.. 31(2): 155-157.
- Baquie P. 2002. Lower limb taping. *Aust Fam Physician*. 31(5): 451-452.
- Beynnon BD, Good L, Risberg MA. (2002) The effect of bracing on proprioception of knees with anterior cruciate ligament injury*. J Orthop Sports Phys Ther* 32(1):11-15.
- Birmingham TB, Kramer JF, Inglis JT, et al. (1998) Effect of a neoprene sleeve on knee joint position sense during sitting open kinetic chain and supine closed kinetic chain tests. *Am J Sports Med* 26(4): 562-566.
- Bower E, McLellan DL. 1992. Effect of increased exposure to physiotherapy on skill acquisition of children with cerebral palsy. *Dev Med Child Neurol. 1*992 Jan;34(1): 25-39.
- Brighton CT, Fisher RS, Levine SE, et al. 1996. The biochemical pathway mediating the proliferative response of bone cells to a mechanical stimulus. *J Bone Joint Surg*. 78-A(9): 1337-1347.
- Brunner R, Krauspe R, Romkes J. 2000. [Torsion deformities in the lower extremities in patients with infantile cerebral palsy: pathogenesis and therapy] Orthopade. 29(9): 808-813. [Article in German]
- Carter DR, Wong M, Orr TE. 1991. Musculoskeletal onotgeny, phylogeny, and functional adaption. *J Biomech.* 24(1):3-16.
- Cusick B. 2005. *Legs & Feet: A Review of Musculoskeletal Assessments*, revised edition. Progressive GaitWays, LLC, Telluride, Colorado. www.gaitways.com. An instructional videotape.
- Cusick B. 2000. *Lower Extremity Musculoskeletal Development* – Orthopedic Interventions for Pediatric Patients - Home Study Course Monograph #10.2.1. Wadsworth C, Editor. Published by the Orthopedic Section, American Physical Therapy Association. LaCrosse, Wisconsin. PH: (800) 444-3982.
- Cusick B. 1990. *Progressive Casting and Splinting for Lower Extremity Deformities in Children with Neuromotor Dysfunction*. Academic Press; www.amazon.com.
- Frost HM. 2004. A 2003 update of bone physiology and Wolff's Law for clinicians. *Angle Orthod.* 74(1): 3-15.
- Frost HM, Schoenau E. 2000. The "muscle-bone unit" in children and adolescents: a 2000 overview. *J Pediatr Endocrinol Metab*; 13(6): 571-590.
- Gajdosik CG, Gajdosik RL. 2000. Musculoskeletal development and adaptation. In SK Campbell (Ed.): *Physical Therapy for Children*, 117-140. Philadelphia, PA: W.B. Saunders Company.
- *Jelks D*, Connolly BH, Zeno M, Griffin J. 2003. wab@compu.net. The effects of the S.W.A.S.H. orthosis on spastic diplegic gait. Poster presentation, APTA Annual Meeting – abstract: www.ptjournal.org/a**b**stracts/pt2003/A**b**s03AuthIn**d**ex.cfm *[AIM: to determine if the S.W.A.S.H. orthosis changes gait speed, stride length and energy expenditure.* ***SUBJECTS:*** *Three boys (4 to 7 years old) with spastic diplegia who had mental ages of at least three years, were ambulatory, continued on the same meds, used lower leg braces, but not the S.W.A.S.H. orthosis and had cooperative, reliable parents were selected. A-B-A design. The variables were recorded weekly for four-week*

periods. ***CONCLUSION:*** *The significant difference in speed and the lack of difference in EEI and stride length are both notable as the S.W.A.S.H. orthosis appears to be a viable option for decreasing gait speed without increasing oxygen costs. This is important since in some children with CP, decreasing gait speed will improve their functional gait patterns.]*

- Jerosh J, Schmidt K, Prymka M. (1997) Proprioceptive capacities of patients with retropatellar knee pain with special reference to effectiveness of an elastic knee bandage. *Unfallchirurg* 100(9): 719-723. [In German] [*The bandage improved proprioception in the injured knees.]*
- Ketelaar M, Vermeer A, Hart H, van Petegem-van Beek E, Helders PJ. 2001. Effects of a functional therapy program on motor abilities of children with cerebral palsy. *Phys Ther.* 81(9): 1534-45.
- LeVeau BF, Bernhardt DB. 1984. Effect of forces on the growth, development, and maintenance of the human body. *Phys Ther.* 64(12): 1874-1882.
- McCullough NC. 1986. Orthotic management. In WW Lovell, RB Winter (eds): *Pediatric Orthopaedics, Second edition, vol 2, 1*031-1060. Philadelphia, PA: JB Lippincott Company.
- Macgregor K, Gerlach S, Mellor R, Hodges PW. 2005. Cutaneous stimulation from patella tape causes a differential increase in vasti muscle activity in people with patellofemoral pain. *J Orthop Res.* 23(2): 351-358. *[Application of stretch to the skin over VMO via the tape can increase VMO activity, suggesting that cutaneous stimulation may be one mechanism by which patella taping produces a clinical effect.]*
- Nuzzo RM. (1980) Dynamic bracing: elastics for patients with cerebral palsy. muscular dystrophy, and myelodysplasia. *Clin. Orthop Rel Res.* 148: 263-270.
- Rennie DJ, Attfield SF, Morton RE, Polak FJ, Nicholson J. 2000. An evaluation of lycra garments in the lower limb using 3-D gait analysis and functional assessment (PEDI). *Gait Posture.* 12(1): 1-6.
- Sellers JS, Capt B (1990) Use of an abduction restraint in facilitating selected motor patterns in a child with Down Syndrome: a case report. *Phys Occupat Ther Pediatr* 9(4): 63-68.
- Stanger M. 1997. Use of orthoses in pediatrics. In Nawoczenski DA, Epler ME (eds.): *Orthotics in Functional Rehabilitation Of The Lower Limb*, 245-272. Philadelphia, PA: W.B. Saunders Co
- Valmassy RL. 1996. Lower extremity treatment modalities for the pediatric patient. In RL Valmassy: *Clinical Biomechanics of the Lower Extremities,* 425-451. St. Louis, MO: Mosby.
- Weseley MS, Barenfeld PA. 1971. Thoughts on in-toeing and out-toeing: pathogenesis and treatment. *Bull Hosp Joint Dis.* 32(2): 182-192.
- Zancan A, Beretta MV, Schmid M, Schieppati M. 2004. A new hip-knee-ankle-foot sling: Kinematic comparison with a traditional AFO. *J Rehab Res Devel*. 41(5): 707-712.

Ataxia

Adler SS, Beckers D, Buck M. 2003. *PNF in Practice: An Illustrated Guide*. New York: Springer Verlag.

- Adolph KE. 2002. Learning to keep balance. *Adv Child Dev Behav.* 30:1- 40. Review.
- Bastian AJ. 1997. Mechanisms of ataxia. *Phys Ther.* 77(6):672-5. Review.
- Bastian AJ, Martin TA, Keating JG, Thach WT. 1996. Cerebellar ataxia: abnormal control of interaction torques across multiple joints. *J Neurophysiol. 7*6(1): 492-509.
- Berger W, Trippel M, Assainte C, Zijlstra W, Dietz V. 1995. Developmental aspects of equilibrium control during stance: a kinematic and EMG study. *Gait Posture* 3: 149-155.
- Berger W, Discher M, Trippel M, Ibrahim IK, Dietz V. 1992. Developmental aspects of stance regulation, compensation and adaptation. *Exp Brain Res. 9*0(3): 610-619.
- Bloedel JR. 2004. Task-dependent role of the cerebellum in motor learning. *Prog Brain Res.* 143: 319-329. Review.

- Butler PB. 1998. A preliminary report on the effectiveness of trunk targeting in achieving independent sitting balance in children with cerebral palsy. *Clin Rehabil.* 12(4): 281-293.
- Cherng RJ, Su FC, Chen JJ, Kuan TS. 1999. Performance of static standing balance in children with spastic diplegic cerebral palsy under altered sensory environments. *Am J Phys Med Rehabil.* 78(4): 336-343.
- Cordo PJ, Gurfinkel VS. 2004. Motor coordination can be fully understood only by studying complex movements.
  Prog Brain Res. 2004;143:29-38. Review
- De Negri M, Rolando S. 1990. Child ataxias: a developmental perspective. *Brain Dev.* 12(2):195-201. Review.
- Ferrarin M, Gironi M, Mendozzi L, Nemni R, Mazzoleni P, Rabuffetti M. 2005. Procedure for the quantitative evaluation of motor disturbances in cerebellar ataxic patients. *Med Biol Eng Comput*. 43(3):349-56.
- Fertel-Daly D, Bedell G, Hinojosa J. 2001. Effects of a weighted vest on attention to task and self-stimulatory behaviors in preschoolers with pervasive developmental disorders. *Am J Occup Ther.* 55(6): 629-640.
- Foudriat BA, Di Fabio RP, Anderson JH. 1993. Sensory organization of balance responses in children 3-6 years of age: a normative study with diagnostic implications. *Int J Pediatr Otorhinolaryngol.* 27(3):255-71.
- Gatev P, Thomas S, Lou JS, Lim M, Hallett M. 1996. Effects of diminished and conflicting sensory information on balance in patients with cerebellar deficits. *Mov Disord.* 11(6):654-64.
- Horak FB, ShupertCL, Dietz V, Horstmann G. 1994. Vestibular and somatosensory contributions to responses to head and body displacement in stance. *Exp. Brain Res.* 100: 93-106.
- Hylton N, Allen C. (1997) The development and use of SPIO Lycra compression bracing in children with neuromotor deficits. *Pediatr Rehabil.* 1(2): 109-116.
- Jeka J, Kiemel T, Creath R, Horak F, Peterka R. 2004. Controlling human upright posture: velocity information is more accurate than position or acceleration. *J Neurophysiol*. 92(4): 2368-79.
- Kuster MS, Grob K, Kuster M, Wood GA, Gachter A. 1999. The benefits of wearing a compression sleeve after ACL reconstruction. *Med Sci Sports Exerc*. 31(3):368-71.
- Morgan MH.1980. Ataxia--its causes, measurement, and management. *Int Rehabil Med.* 2(3): 126-32. Review.
- Morton SM, Bastian AJ. 2004. Cerebellar control of balance and locomotion. *Neuroscientist.* 10(3): 247-59. Review.
- Nashner L. 1976. Adapting reflexes controlling the human posture. *Exp. Brain Res.* 26: 59-72.
- Nashner L. 1985. Strategies for organization of human posture. In Igarashi M, Black FO. Eds: *Vestibular and Visual Control on Posture and Locomotor Equilibrium,* p. 1-8. Basel, Switzerland: Karger.
- Olson LJ, Moulton HJ. 2004. Use of weighted vests in pediatric occupational therapy practice. *Phys Occup Ther Pediatr.* 24(3): 45-60.
- Olson LJ, Moulton HJ. 2004. Occupational therapists' reported experiences using weighted vests with children with specific developmental disorders. *Occup Ther Int.* 11(1): 52-66.
- Roncesvalles MN, Woollacott MW, Burtner PA. 2002. Neural factors underlying reduced postural adaptability in children with cerebral palsy. Neuroreport. 13(18): 2407-2410.
- Shumway-Cook A, Hutchinson S, Kartin D, Price R, Woollacott M. 2003. Effect of balance training on recovery of stability in children with cerebral palsy. Dev Med Child Neurol. 45(9): 591-602.

- Wang RY. 1994. Effect of proprioceptive neuromuscular facilitation on the gait of patients with hemiplegia of long and short duration. Phys Ther. 74(12): 1108-15.
- Woollacott MH, Shumway-Cook A. 2005. Postural dysfunction during standing and walking in children with cerebral palsy: what are the underlying problems and what new therapies might improve balance? Neural Plast. 12(2-3):211-9; discussion 263-72. Review.
- Woollacott MH, Burtner P. 1996. Neural and musculoskeletal contributions to the development of stance balance control in typical children and in children with cerebral palsy. Acta Paediatr Suppl. 416: 58-62.
- VandenBerg NL. 2001. The use of a weighted vest to increase on-task behavior in children with attention difficulties. Am J Occup Ther. 55(6): 621-628.
- van der Heide JC, Hadders-Algra M. 2005. Postural muscle dyscoordination in children with cerebral palsy. Neural Plast. 12(2-3): 197-203; discussion 263-72.
- Voss DE. 1991. Voss & Knott's Proprioceptive Neuromuscular Facilitation. Lippincott Wiliams and Wilkins.

Sensory Integration

- Bekker EM, Overtoom CC, Kooij JJ, Buitelaar JK, Verbaten MN, Kenemans JL. Disentangling deficits in adults with attention-deficit/hyperactivity disorder. Arch Gen Psychiatry. 2005 Oct;62(10):1129-36.
- Blazquez-Almeria G, Joseph-Munne D, Buron-Maso E, et al. 2005. [Results of screening for symptoms of attention deficit disorder with or without hyperactivity in schools by means of the ADHS scale.] Rev Neurol. 2005 Nov 16-30;41(10):586-90. [Article in Spanish] *[The analysis of the data obtained showed that 12% of the subjects in our sample were at risk of ADHD, which means that one out of every eight schoolchildren could have this disorder. Boys scored consistently higher than girls in almost all of the subscales of the ADHS, the proportion being 4:1.]*
- Dimoska A, Johnstone SJ, Barry RJ, Clarke AR. 2003. Inhibitory motor control in children with attention-deficit/hyperactivity disorder: event-related potentials in the stop-signal paradigm. *Biol Psychiatry.* 15;54(12): 1345-54.
- Fertel-Daly D, Bedell G, Hinojosa J. 2001. Effects of a weighted vest on attention to task and self-stimulatory behaviors in preschoolers with pervasive developmental disorders. *Am J Occup Ther.* 55(6): 629-640.
- Hern KL, Hynd GW. Clinical differentiation of the attention deficit disorder subtypes: do sensorimotor deficits characterize children with ADD/WO? *Arch Clin Neuropsychol*. 1992;7(1): 77-83.
- Hylton N, Allen C. (1997) The development and use of SPIO Lycra compression bracing in children with neuromotor deficits. *Pediatr Rehabil.* 1(2): 109-116.
- Jansiewicz EM, Newschaffer CJ, Denckla MB, Mostofsky SH. 2004. Impaired habituation in children with attention deficit hyperactivity disorder. *Cogn Behav Neurol*. 17(1): 1-8.
- Lijffijt M, Kenemans JL, Verbaten MN, van Engeland H. 2005. A meta-analytic review of stopping performance in attention-deficit/hyperactivity disorder: deficient inhibitory motor control? *J Abnorm Psychol.* 114(2): 216-22.
- Olson LJ, Moulton HJ. 2004. Use of weighted vests in pediatric occupational therapy practice. *Phys Occup Ther Pediatr.* 24(3): 45-60.
- Olson LJ, Moulton HJ. 2004. Occupational therapists' reported experiences using weighted vests with children with specific developmental disorders. *Occup Ther Int.* 11(1): 52-66.
- Pliszka SR, Liotti M, Woldorff MG. 2000. Inhibitory control in children with attention-

deficit/hyperactivity disorder: event-related potentials identify the processing component and timing of an impaired right-frontal response-inhibition mechanism. *Biol Psychiatry.* 1;48(3): 238-246.

- Satterfield JH, Schell AM, Nicholas TW, Satterfield BT, Freese TE. 1990. Ontogeny of selective attention effects on event-related potentials in attention-deficit hyperactivity disorder and normal boys. *Biol Psychiatry.* 15;28(10):879-903
- Smith JL, Johnstone SJ, Barry RJ. 2004. Inhibitory processing during the Go/NoGo task: an ERP analysis of children with attention-deficit/hyperactivity disorder. *Clin Neurophysiol*. 115(6): 1320-1331.
- VandenBerg NL. 2001. The use of a weighted vest to increase on-task behavior in children with attention difficulties. *Am J Occup Ther.* 55(6): 621-628.
- Yordanova J, Banaschewski T, Kolev V, Woerner W, Rothenberger A. 2001. Abnormal early stages of task stimulus processing in children with attention-deficit hyperactivity disorder--evidence from event-related gamma oscillations. *Clin Neurophysiol*. 112(6): 1096-1098.\

Ankle DF

- Barry LD, Barry AN, Chen Y. 2002. A retrospective study of standing gastrocnemius-soleus stretching versus night splinting in the treatment of plantar fasciitis. *J Foot Ankle Surg.* 41(4): 221-227. *[160 patients with unilateral or bilateral plantar fasciitis. 71 patients performed standing stretching of the gastrocnemius-soleus complex. 89 patients used the Straasburg Sock, a prefabricated night splint without standing stretching. The night splint treatment group had a significantly shorter recovery time, fewer follow-up visits to recovery, and fewer total additional interventions compared to the stretching group. Conclusion: Early treatment in a standardized four-tiered treatment approach, including the night splint without standing stretching of the gastrocnemius-soleus complex, speeds time to recovery.]*
- Yokoyama O, Sashika H, Hagiwara A, Yamamoto S, Yasui T. 2005. Kinematic effects on gait of a newly designed ankle-foot orthosis with oil damper resistance: a case series of 2 patients with hemiplegia. *Arch Phys Med Rehabil*. 86(1): 162-166. *[Plantarflexion resistive moment should be easily adjustable according to the gait ability of patients with hemiplegia. We developed an AFO with an oil damper - a small hydraulic shock absorber that generates a resistive moment to ankle PF at the initial stance phase. The magnitude of the PF resistive moment at the heel strike can be easily adjusted. Gait analysis comparing 2 hemiplegic patients while they were wearing either the AFO with the oil damper or the AFO with the PF stop revealed that the AFO with the oil damper achieved sufficient ankle PFand mild knee flexion by adjusting a proper* PF resistive moment during initial stance phase, and a more comfortable gait than did the AFOs with a PF stop.]
- DeVita P, Torry M, Glover KL, Speroni DL. 1996. A functional knee brace alters joint torque and power patterns during walking and running. *J Biomech.* 29(5): 583-538.