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

Effectiveness of TheraTogs Applications:


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


*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.

- 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, sinusoidal 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.
- 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.


[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° (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.]

- Mueller® Basic principles of athletic taping. (Available at Medco Sports Medicine: www.medco-athletics.com - 800-556-3326.)
  > 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.
  > [BEVERLY CUSICK: Essential. Tough reading at times, but certainly worth the wait!!]
  > [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.]
- 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.]
- 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.]


**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.


shoulder forward flexion in all 37 PT student subjects.]


- 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.


- 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.]


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.]


- 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.]


- Snijders CJ, Hermans PF, Niesing R, Spoor CW, Stoeckart R. 2004. The influence of slouching and lumbar support on ililolumbar 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 ililolumbar ligaments when protection from back muscles against lumbar flexion is absent. Lumbar backrest support almost eliminates lumbosacral and sacroiliac movement. RELEVANCE: Understanding why the ililolumbar 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.


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

- 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/abstracts/pt2003/Abs03AuthIndex.cfm](http://www.ptjournal.org/abstracts/pt2003/Abs03AuthIndex.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.]


- 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.]


**Ataxia**


Sensory Integration


- 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.]


- 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.


### 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 PF and 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.]