

Deep Pressure Sensory Input

SPIO FLEXIBLE COMPRESSION BRACING

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As pediatric physical and occupational therapists, our goal is often to assist children in developing and utilizing postural control, balance, and movement mechanisms to perform daily activities in the most efficient and least energy-consuming manner. Often this requires the use of therapeutic aids. At Children's Therapy Center in Kent, Washington, numerous years of experience with flexible ankle/foot bracing has led to the development and utilization of other flexible bracing systems to improve stability, balance, and movement.

For over 10 years, therapists have been conducting trials, with much anecdotal success, on the use of a functional compression bracing system or Stabilizing Pressure Input Orthosis (SPIO) system to assist children with sensory-motor, neuromotor, or musculoskeletal deficits.

IAN'S EXPERIENCE WITH COMPRESSION

Our earliest experiences in flexible compression bracing began in the mid 1980's. However, it wasn't until 1994 that deeper exploration of this therapeutic tool began. Cheryl Allen, parent of Brian, a boy receiving physical therapy treatment, was on a quest to find a material that could "mimic" the deep pressure sensory information that physical therapist Nancy Hylton was providing through her hands to Cheryl's son. After three or four attempts, Cheryl began fabricating Lycra compression shorts that significantly improved Brian's ability to control movement and bear weight through his trunk and lower extremities.

Cheryl's second son, Ian, began receiving physical therapy with Nancy Hylton at three months of age due to early sensory-motor difficulties, including strong opisthotonic posturing, impaired postural control, difficulties with movement, and marked hypersensitivity to environmental stimuli. At 10 months of age, Ian could sit alone for several seconds but did not have any transitional movements or a means of floor mobility.

One morning during therapy, Nancy wrapped Ian several times with a four-inch wide Ace Wrap from one shoulder diagonally, between his legs, to the other shoulder, finishing off with circular wraps around his trunk. Once placed on the floor, Ian immediately began to commando crawl across the floor. Cheryl went home and fabricated Ian a Lycra body suit in an effort to duplicate the effect of the Ace Wrap in therapy. Within a week, Ian was rocking on his hands and knees and crawling reciprocally.

In addition, Ian was less easily over-stimulated by environmental noises and began to explore his environment in a much more secure and meaningful way. When the Lycra was removed, Ian did begin to lose function. However, Ian gradually began to show more carry-over in function when the Lycra body suit was off as a more organized motor plan emerged. Today Ian can function with his

suit off; however, he does continue to function better with it on.

WHAT IS SPIO AND HOW IS IT DIFFERENT FROM OTHER FLEXIBLE COMPRESSION SYSTEMS?

SPIO stands for Stabilizing Pressure Input Orthosis. It is a highly flexible bracing system made from specialized multi-directional stretch Lycra with excellent rebound and memory so that it returns to its original shape. Since deep pressure appears to be an important somatic input for balance and movement control, SPIO is designed to provide and enhance deep pressure sensory input around and toward the midline of the body to improve dynamic stability and postural activation.

The Lycra material and the use of specific compression ratios provides a multi-directional and steady stretch tension directly to the skin and indirectly to the internal soft tissue structures. This precise compression provides accurate and usable deep pressure sensory information to the child's proprioceptive feedback system resulting in improved positional limb and body awareness, improved core muscle and joint stabilization, and increased precision of muscle activation and movement.

Since the SPIO system does not "restrict" movement, it permits distortion away from the midline orientation of the body in all planes of movement. The memory rebound of the fabric, however, creates a dynamic force back toward the midline of the body, thereby improving active stabilization. This allowance of movement has proven beneficial for improving motor learning by assisting movement back toward midline orientation and increasing the predictability of the environment for movement.

SPIO is different from other flexible compression garments. The UP Suit or Second Skin, the GPS Orthosis, the Benik vests, and TheraTogs primarily attempt to improve biomechanical stability by exerting inhibitive and counter-stabilizing forces to manage spasticity, muscle pull, and deformity. The effects of providing deep pressure sensory input through the use of these flexible compression systems are only secondary.

PATIENT SELECTION

The SPIO orthosis appears to be most beneficial for those children who exhibit a primary or secondary sensory deficit which is impairing dynamic stability, postural activation, and movement control. We have found SPIO to be most helpful for children with: 1) moderate to severe hypotonia, particularly axial hypotonia, 2) deficits in dynamic stabilization, tone fluctuations, and unpredictable movement control from dyskinesia, 3) moderate-to-severe hypertonia that is compensatory for poor deep sensation, 4) whole body sensory awareness deficits, and 5) some types of sensory integration problems.

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For the best outcome, great care must be exercised in the selection and utilization of SPIO for specific individuals. Testing the potential helpfulness of a SPIO orthosis can be done easily by using elastic wraps to identify the elicited motor response to increased deep pressure input.

STYLES OF SPIO

VEST: Double- or triple-layer compression around the shoulder, trunk, pelvis, and hips is provided by the SPIO vest. It has a less flexible Velcro-sensitive back to which the front portion can be attached and adjusted to provide optimal cylindrical chest, abdominal, and pelvic compression to assist core muscle activation and stabilization. Shoulder extensions are individually adjusted for tension and angle of pull. The orthosis is pulled down over the hips and an anchor strap is fastened between the legs to prevent upward creeping on the trunk.

The SPIO vest is ideal for children with poor core muscle activation, stabilization, or weakness. Children with the diagnosis of severe axial hypotonia, athetoid quadriplegia, Spinal Muscular Atrophy, or Benign Anterior Horn Cell Disease may benefit from the use of the SPIO vest.

To permit maximum freedom of movement in situations of neuromuscular scoliosis and as a trial compression orthosis, the SPIO vest can also be used in conjunction with a very flexible custom molded Thoracic Lumbar Sacral Orthosis (TLSO).

PANTS: SPIO pants provide either single- or double-layer compression from the lower ribcage to the calf or ankles. It has proven beneficial for children and adults with spastic diplegia who demonstrate deficits in sensory awareness and stability.

PANTS AND VEST: This SPIO style was an evolution of the vest, used when children with sensory deficits had difficulty managing independent standing and walking. The pants and vest provide double- or triple-layer compression to the trunk, pelvis, and hips, as well as single or double layer compression to the lower extremities.

A boy began physical therapy as an infant due to marked hypotonia and sensory-motor difficulties. The early use of a SPIO vest assisted independent sitting balance by two years. At three years of age, SPIO pants were added to the vest to assist with independence in pull to stand activities and ambulation with a walker. He continued the use of the SPIO vest and pants and began to walk independently without assistive devices by six years of age.

PANTS AND SHIRT: This SPIO style provides single-layer compression to the arms, trunk, and legs. It is best suited for children with primary sensory awareness deficits. Based on individual need, the orthosis can cover to the wrist and ankle or to the elbow or knee. Calf length provides knee coverage for improved knee awareness and forearm length for improved fine motor control. The material can also be potentially doubled above the elbow and (continued on page 11)

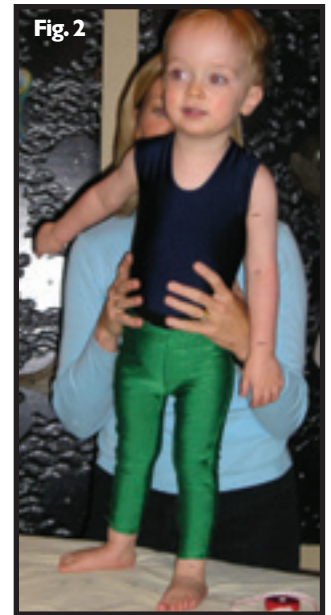


Fig. 1a. (top, left) Five-year-old girl with Severe Athetoid Quadriplegia. **Fig. 1b.** (at left) Donning a SPIO vest brought immediate improvement in active head, trunk, and limb control with reduction in dystonic spasm noted. **Fig. 2.** (top, right) Two-year-old boy with hypotonia. He initially wore only a SPIO vest to assist with shoulder/trunk/hip stability. SPIO pants were added to assist with improving strength and stability in standing.

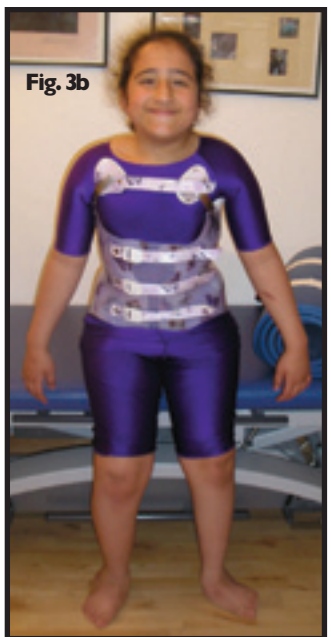
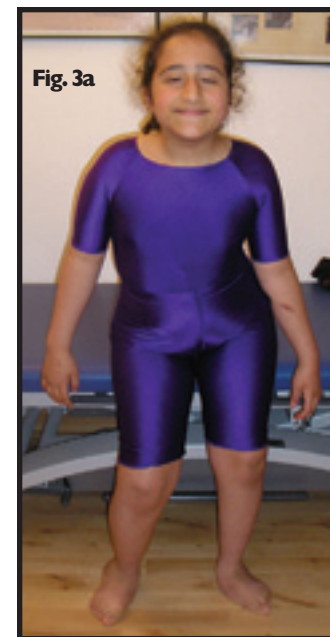


Fig. 3a. (above, left) Twelve-year-old girl with cerebral palsy and severe kyphoscoliosis. She wears a SPIO shirt and pants daily to improve sensory awareness and stability. **Fig. 3b.** (above, right) Cheneau de-rotational TLSO is added to help control her back curvature.

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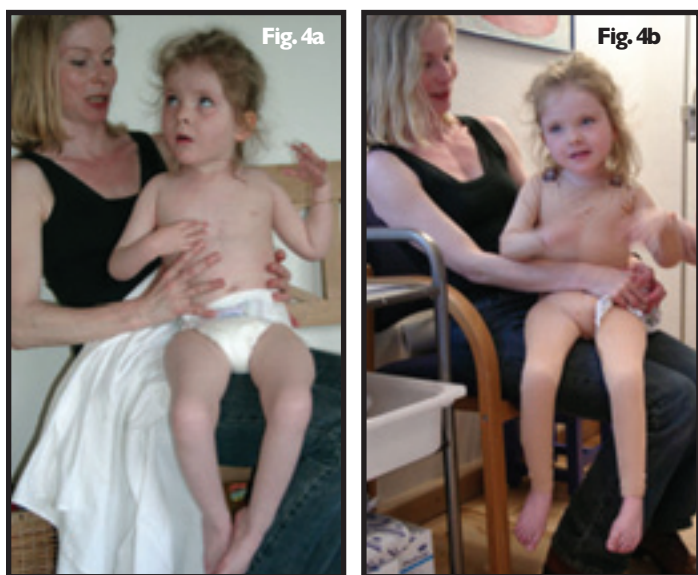


Fig. 4a. (above, left) Six -year-old girl with Rett Syndrome. Head and trunk control are very poor in supported sitting without the SPIO shirt and unitard.
Fig.4b. (above, right) The SPIO system provides deep pressure input and increased shoulder/trunk/hip stability to improve functional head and trunk control, as well as improved visual attention and tracking.

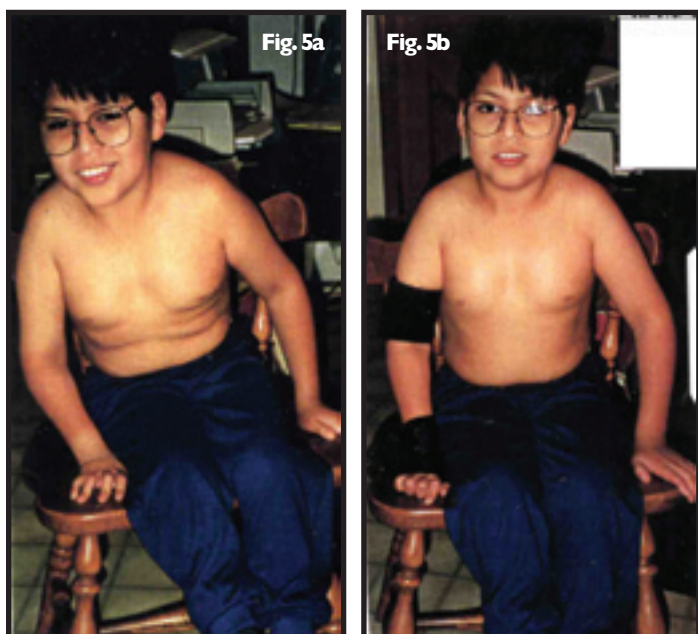


Fig. 5a. (above, left) Nine-year-old boy with asymmetric spastic quadriplegia without SPIO support shows increased gripping of the left hand and increased trunk asymmetry as a compensatory mechanism for poor right arm control.
Fig. 5b. (above, right) Positive changes are noted in trunk, head, and bilateral arm control with donning of three-layer SPIO right upper extremity compression band combined with single-layer glove over custom polyethylene hand/wrist splint.

knee for other activities. The shirt portion is measured to pull over the hips and the pant portion typically extends to the lower ribcage for maximum growth.

SHIRT AND UNITARD: Different from the shirt and pants combination, the shirt and unitard provides double-layer compression to the shoulder, trunk, hips, and pelvis while providing only single-layer compression to the arms and legs.

Children who have a combination of axial instability and sensory awareness deficits, such as spastic quadriplegia, Angelman Syndrome, and Rhett Syndrome, may benefit from the use of this SPIO style.

COMPRESSION WRAPS: These offer double or triple layer compression to different body segments, including the abdomen, the upper arm, the upper leg, or the lower leg.

The abdominal compression wrap offers similar support as other elastic abdominal wraps, but is more flexible and can comfortably provide support from the lower ribs to the hips. These can be customized with additional vertical flexible stays and have a firmer Velcro sensitive panel to which the wrap attaches for greater adjustability.

Upper arm compression wraps provide improved sensory awareness and shoulder and elbow muscle control and function in persons with spastic hemiplegia and asymmetric quadriplegia. If spasticity is compensatory for decreased sensory awareness, a reduction in local spasticity is common.

A combination of lower extremity compression wraps over the thigh and calf have been successfully used to improve active knee control and reduce equinus. Lower extremity segmental compression wraps have proven very helpful for persons with spastic hemiplegia or mild to moderate spastic diplegia.

COMPRESSION GLOVE: This orthosis evolved from a Ninja costume which Cheryl Allen made for her son, Ian. Ian, curiously, did not want to remove his gloves and displayed greater tactile exploration and precision with them on. Persons with hemiplegia and athetoid or spastic quadriplegia have shown decreased hypersensitivity and improved hand use with this single layer orthosis which extends from the metatarsal heads to above the wrist.

CONTRAINDICATIONS AND POTENTIAL DIFFICULTIES USING SPIO

It is typical to see improved respiratory function in children wearing a SPIO orthosis, including decreased respiration rate, larger and more fluid ribcage expansion, improved rhythm of breathing, and an increased ability to independently cough. Most likely, abdominal compression improves the biomechanics of the diaphragm resulting in these findings. However, strong caution should be exercised when utilizing any compression orthosis with children who have cardiovascular impairments or ribcage restrictions. (continued on page 12)

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Children with neurological deficits are at greater risk for temperature regulation impairments and should be monitored carefully. Many children in warm environments have worn SPIO comfortably due to the increased breathability of the Lycra material. However, the back of the SPIO vest is fabricated from neoprene and extra sweating can be experienced. The use of ventilated neoprene can be used to help alleviate this concern.

Toileting can be an issue with some children and should be considered in the use of a SPIO system. A SPIO system is worn over the diaper or undergarments and can pose a challenge for some children who are learning to toilet independently. SPIO pants are easier for independent toileting than a unitard. Special modifications can be made to the vest to fasten the anchor strap in front rather than the back to make toileting easier. These modifications have been successfully used in children from preschoolers to adolescents with good success, depending on the degree of manual dexterity.

As with the use of any sensory modality, children with seizure disorders should be monitored carefully when utilizing SPIO. If seizures increase with the use of SPIO compression, this modality should be discontinued.

FINAL THOUGHTS

SPIO compression systems have not been used in isolation. They are one of many therapeutic tools which are used to help assist and carry-over improved balance, active stability, and movement control, both during therapy sessions and throughout daily tasks.

We strongly believe that in most cases, a stable base of support must be provided prior to the implementation of any SPIO flexible compression system. In order to provide a more stable base of support, most children at Children's Therapy Center wear either flexible dynamic foot orthoses or supramalleolar dynamic ankle foot orthoses to improve the biomechanical alignment and sensory awareness of their feet.

In addition, we continue to use Benik products in conjunction with the SPIO system, especially where greater mechanical stability is required. Most commonly we use Benik thumb/hand/wrist splints with and without moldable thermoplast, knee extension bracing with moldable theramoplast or stays and TLSOs with moldable thermoplast. Many other systems can also be used in conjunction with SPIO to help provide the most optimal results for the children we serve.

WHERE CAN SPIO BE OBTAINED?

Due to the severe illness of Cheryl Allen, SPIO orthoses have not been fabricated in the United States for over the past 2 years. Children's Therapy Center in Kent, Washington, has very recently begun fabricating these orthoses in the United States and will begin to offer one-day seminars to therapists and orthotists on the function, selection, and measurement for the use of this flexible compression system. SPIO vests, shirts, pants, unitards, and gloves

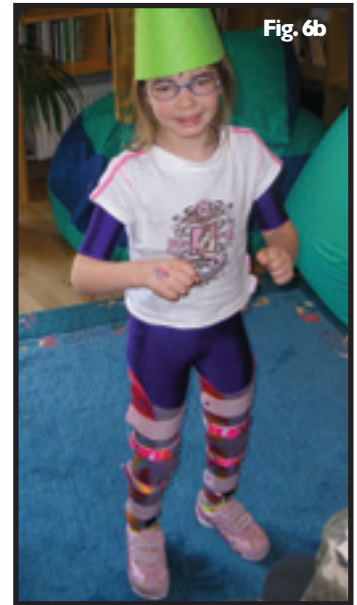


Fig. 6a. (above, left) Seven-year-old girl with spastic diplegia wears a SPIO shirt, unitard and dynamic ankle foot orthotics without molded knee extension splints. Without the SPIO shirt and unitard, spasticity increased significantly throughout the body, especially in the lower extremities. With SPIO alone, active extension, balance, stability, and movement control are improved. **Fig. 6b.** (above, right) With SPIO plus polyethylene knee braces, she is able to balance for several minutes independently in free stand and ambulate with the use of a Kaye posture walker or quad canes.

are available in many youth sizes to ensure proper fit. SPIO systems are also covered by most insurance providers. Call for a price list and more information at 877/997-SPIO (7746) or visit our website at www.spioworks.com

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