APTA Academy of Pediatric Physical Therapy

FACT SHEET

Foundations of Pediatric Orthotics

INTRODUCTION

The goal of this fact sheet is to provide a reference highlighting key points of orthotic management in children. Additional information on pediatric orthotic management can be located in the Atlas of Orthoses and Assistive Devices, edited by the American Academy of Orthopedic Surgeons, and Lower Extremity Orthotic Intervention for the Pediatric Client in Topics in Physical Therapy: Pediatrics, edited by the American Physical Therapy Association.

WHAT IS AN ORTHOSIS?

An orthosis, known more commonly as a brace, is a device that fits over a part of the body with controlling forces designed to: improve body alignment; improve function; immobilize the injured area; prevent or improve a deformity; protect a joint or limb; limit or reduce pain; and/or provide proprioceptive feedback. Orthoses are named for the part of the body they cover. Orthoses can be custom molded, and custom fitted (custom fitted from prefabricated orthoses or off the shelf). Orthoses are classified as durable medical devices (DME) and require L-codes for insurance reimbursement. A prescription signed by a physician is usually required for insurance reimbursement for custom-molded and custom-fit orthoses.

WHO DESIGNS AND PROVIDES ORTHOSES?

- Certified orthotists, CO, have formal education in biomechanics and material sciences required in designing custom devices. They are nationally board certified, and 15 states require licensure to provide custom devices. There are 4722 Certified Orthotists (1609 CO’s and 3113 Certified Prosthetists Orthotists [CPO’s] per the American Board for Certification in Orthotics and Prosthetics, Inc. April, 2020) in the US, with a limited number of orthotists specializing in pediatrics. Pediatric orthotists evaluate and measure the patient, provide direction of fabricate the orthosis, and custom fit the orthosis to the patient. Following delivery of the orthosis, physical therapists and orthotists collaborate to provide education and functional training to the patient and family.
- Physical therapists are trained in the function of many orthotic devices and will occasionally fit and measure orthoses. Some therapists fabricate and fit low-temperature orthotic devices/splints, requiring training beyond their basic education. Some physical therapists, often in conjunction with orthotists, help design and/or do research on orthoses and care for the patients. Elaine Owen, PT, MBE, MS, Beverly Cusick, PT, MS, Kristie Bjornson, PT, PhD, and Nancy Hylton, PT are some pioneering physical therapists that have contributed to orthotic design/function.
- Physicians, orthotists, occupational therapists, and physical therapists often provide simple, off-the-shelf orthoses for patients in acute situations. The sizing of these devices is determined by measurement and has limited adjustments.
- Families can purchase some types of orthoses at pharmacies, sport stores and online.

WHO IS ON THE TEAM?

A team approach is always recommended for optimal outcomes. The patient's rehabilitation team should include physicians, orthotists, physical therapists, occupational therapists, social workers, and most importantly the patient and family. Physical therapists and occupational therapists working with the patient and family in schools and community rehabilitation settings play an integral role in developing the orthotic prescription. The assessment and goals for the patient should be addressed with the orthotist. The orthotist also performs a comprehensive evaluation and will collaborate thoughts with the therapist.

Diagnosis, prognosis, short- and long-term goals, home environment, occupation, recreation, age, height, weight, and prior orthotic experience(s) should all be discussed among the rehabilitation team when determining which devices are most appropriate for the patient's current and future needs. Considerations include cost as well as adjustability of the device to meet the patient's changing growth and developmental needs.

WHAT ARE THE CHARACTERISTICS OF PEDIATRIC ORTHOSES?

Design: General

- 3-point pressure systems are utilized in most orthoses or orthotic devices to control or stabilize a body segment. A 3-point pressure system consists of 2 stabilizing forces on the same side of a limb/ torso on proximal and distal ends of the body segment, and an opposite corrective force between the stabilizing forces and typically at an anatomical joint.

3-point pressure system to stretch wrist flexion contracture
(photo courtesy of Children's Healthcare of Atlanta)

- Orthoses should optimize leverage for control without resisting desired range of motion for activities or undo pressure that can cause pressure on underlying nerves and soft tissues (eg, peroneal nerve palsy). Range of motion may be restrictive to control function (eq, a spinal orthosis not allowing more than 90 degrees hip flexion to stabilize sacral-lumbar level conditions).
- Orthoses may be initially fabricated to provide maximum stability and then be adjusted for less stability and more voluntary control as the patient progresses.
- Designs and colors have greatly improved acceptance by allowing the patient to personalize and have a choice in designing the orthosis.
- Transverse rotation control of the extremities (hip or shoulder internal/ external rotation) requires the patient to wear an orthosis that connects to the torso or pelvis to optimize transverse leverage or the other extremity. Forearm pronation/ supination can also be addressed with an orthosis.

Materials:

- There are numerous types and thicknesses of materials to choose from when fabricating an orthosis. The orthotic prescription and the appropriate material and design of the orthosis are essential for function, strength, durability, flexibility, comfort, adjustability, compliancy, hygiene, and skin integrity.
- The patient's height, weight, and activity level determine the materials chosen.
- Most orthoses are made from vacuum-molded thermoplastics. Plastic thicknesses can vary between 1/16" to ¼". Occasionally, metal/leather/neoprene designs are appropriate.
- Carbon graphite/acrylic resin will increase the strength and decrease the bulk of an ankle foot orthosis (AFO); however, these materials are not as adjustable or durable to abrasion as thermoplastics.

Straps:

Strap designs vary depending on the function and control of the orthosis:

- Chafe and loop designs optimize stability but may be more difficult to don and have high bulk.
- Figure-eight ankle straps have good control and moderate bulk.
- Layover straps provide minimal stability and minimal bulk.
- Other options to fasten the orthoses include laces, zippers, and BOA® systems.

Straps help align and hold the limb in the orthosis and may have direct contact with the limb. Straps should fit securely and not gap between the plastic orthosis and the patient's limb. This increases stability and decreases unnecessary pressure. Straps are often a major source of 3- point pressure systems and must be used correctly to optimize control.

Pads/ Padding:

- Pads are often provided in areas where there are bony prominences. They are used to support and cushion these areas of concern.
- Pads may be applied in an orthosis after fabrication or after physiologic changes occur. The pads are applied to increase the 3-point pressure systems in order to improve alignment.
- Pads should never be applied in an area of the orthosis that is already providing excessive pressure to the patient. Even the softest padding will increase the pressure in this area.
- Shear materials such as ShearBan® or moleskin can be used in conjunction or in the place of padding to reduce friction which often is the main cause of skin irritations.

Trim Lines:

- Trim lines are the edges of the orthoses and are determined based on the patient's body shape, size, and functional needs.
- Trim lines should optimize leverage for control without impinging undesired areas of the body, adding bulk to make clothing or shoe wear hard to fit over the device.

Advanced Technology:

Recent technology advances incorporate computer microprocessors in the orthosis to improve function. As of now, these orthotic devices are not appropriate for the younger population. They are limited to size restrictions of the components and are not meant to take on the activities that children can apply to an orthosis (water, dirt, high impacts).[1]

CAN AN ORTHOSIS BE USED FOR CONTRACTURE PREVENTION/REDUCTION?

The rehabilitation team should determine if an individual patient has potential for correction of a contracture or if a goal is prevention of developing or having a contracture worsen. Adherence of the device regimen is essential for success. Other interventions for control also should be considered (eg, serial casting, anti-spasticity medications, electrical stimulation). The determination should reflect which orthotic options below would produce the best outcome.

Types of Orthotic Function:

- Dynamic assistive orthoses have an adjustable tension-spring assistance mechanical joint to reduce or prevent anatomical joint contractures.
- Static progressive orthoses hold a stretch with a manual force applied to the anatomical joint. Increased range may be achieved with increased manual stretch.
- Static orthoses have no adjustability and hold the limb in one position.

Custom vs. Off-the-Shelf:

- Custom-made orthoses are indicated for long-term implications and multiple-plane control. They are indicated for patients with:
    - chronic conditions
    - demonstrate high muscle tone/spasticity
    - fluctuations in range of motion
    - good to poor skin integrity
    - limited tolerance to wearing the orthoses and agitation
- Off-the-shelf orthoses are indicated for patients with acute conditions who have range of motion with limited restrictions and good skin integrity may benefit from off-the-shelf styles. They are typically less durable than custom made and indicated for acute conditions of limited range of motion. There are options for purchase or rental of some orthoses.

TUNING OF AFO'S AND SHOES

- Tuning is the process of dynamic alignment of the orthosis/ shoe with the patient's abilities and ground reaction forces.
- Tuning the orthosis is essential to proper function. Tuning of lower extremity devices was made popular by, Elaine Owen, MSc SRP MCSP, who has contributed a wealth of research on the use of orthoses. Elaine's work has focused on:
    - The sciences of kinematics and kinetics in the normal and abnormal human gait cycle
    - Algorithms designed to choose the proper clinical path
    - Determining the proper lower extremity orthotic design and shoe modifications needed to optimize gait.[2,3,4]
- Shoe design and modifications impact the function of the orthosis and the patient's function when exposed to the ground reaction forces. For example, a shoe with a hard sole and no posterior rocker would encourage a knee flexion moment at initial contact.
- A functional weight-bearing lower extremity orthosis must be tuned to ensure the patient can maintain a stable upright position and promote smooth gait while accommodating joint contractures or angular deformities. The patient should have a thorough evaluation to determine the functional limitations with strength and range of motion, joint alignment, and balance. If a patient's alignment cannot be corrected, the orthosis will need to accommodate the deformity.

LOWER EXTREMITY ORTHOSES

Common Terms:

- Foot orthosis (FO)
- Supramalleolar orthosis (SMO)
- Ankle Foot Orthosis (AFO)
  - SAFO (Solid AFO)
  - AAFO (Articulated AFO)
  - PLSAFO (Posterior Leaf Spring AFO)
  - FRAFO/ GRAFO (Floor or Ground Reaction AFO)
- Knee Ankle Foot Orthosis (KAFO)
- Hip Knee Ankle Foot Orthosis (HKAFO)- may include a waist band, lumbosacral (LSO) or thoracolumbosacral orthosis (TLSO)
- Reciprocating Gait Orthosis (RGO)
- Torsion/ Twister straps/cables
- Hip Orthosis (HO)
- Fracture Orthoses

Orthoses are specifically designed for the patient's functional needs, whether ambulatory or non-ambulatory, with considerations of:

- 3-point pressure systems and ground reaction forces to control alignment in all 3 planes.
- improving, controlling, or limiting joint movements
- simulating an eccentric or concentric muscle function
- increasing range of motion
- providing proprioceptive feedback
  - This is achieved by incorporating mechanical joints, springs, or flexible materials into the orthotic design.
- The length of the footplate of an orthosis may vary depending on the child's need:
  - Full-length footplate (to end of toes) to provide resistance to keep the knee from buckling or crouching utilizing ground reaction forces. They may be utilization with a toe extensor pad for hypertonia, painful metatarsal phalangeal (MTP) joint, or if toes have a tendency to curl.
  - Trimming the footplate to stop behind the toes (sulcus) is indicated to allow a normal third rocker (MTP dorsiflexion) and often allows easier shoe donning. This is indicated for children whose knees hyperextend in 2^{nd} and 3^{rd} rocker of gait.
  - Trimming the footplate to stop behind MT heads (rare in children) is indicated for painful metatarsal (MT) heads.
  - Full-length footplates may be designed with thin plastic, or the plastic may be thinned after fabrication to allow more dorsiflexion flexibility in the third rocker.

WHAT TYPE OF SHOES SHOULD BE WORN WITH A LOWER EXTREMITY ORTHOSIS?

- Shoes should have:
  - Good construction, leather or other strong materials preferred
  - Supportive heel counter
  - Quality sole that flares out slightly or goes straight down. Sole should not be able to be excessively twisted by hand.
  - A removable insole to increase instep depth
  - Rockered toe (rockers may vary and amount of rocker needed depends on the functional need of the patient) and/or heel.

- Laces or Velcro closure to instep or zipper that goes around the back of the heel.
- The fit of the shoe can affect orthotic function. The clinician can assist the patient and family in selecting the proper shoe for the prescribed orthosis.
- The heel height of the shoe will affect the patient's standing alignment while in the brace. The orthotist can discuss preferred heel height for best function.
- Additional heel lift or shoe lifts might be needed depending on gait presentation and leg length discrepancy. "Tuning" an orthosis and shoe to optimize function is essential for best outcomes.

TABLE 1: Lower-Extremity Orthoses and Indication in the Gait Cycle

PHOTO OF THE ORTHOSIS	DEVICE	PATIENT PRESENTATION	MATERIAL	BIOMECHANICAL PRINCIALS
 Photo courtesy of Children's Healthcare of Atlanta	Foot Orthosis (FO)	• Pes planovalgus (mild/ moderate) • Accessory navicular • Posterior tibialis dysfunction • Metatarsalgia • Toe-walking • Foot pain	• Foam top layer (optional) • Firm base made of thermoplastic, carbon, crepe, or cork	• Longitudinal and/or transverse arch support • Extrinsic support to improve/ accommodate malalignment of the foot/ ankle • Shock absorption
 Photo courtesy of Children's Healthcare of Atlanta	UCBL, University of California Biomechanics Laboratory	• Pes Planovalgus (moderate/ severe) • Plantar fasciitis • Metatarsus adductus	• Thermoplastic	• Stabilizes foot/ankle complex in coronal and transverse planes • Reduces stress on plantar fascia
 Photo courtesy of Children's Healthcare of Atlanta	Supra Malleolar Orthosis (SMO)	• Moderate to severe pronation or supination • Balance problems in early ambulation[5] • Toe walking	• Thermoplastic	• Stabilizes foot/ankle complex in coronal and transverse planes

  Photo courtesy of Children's Healthcare of Atlanta	Posterior Leaf Spring (PLS) Ankle Foot Orthosis (AFO)	• Drop foot • Charcot Marie Tooth • Peroneal palsy with mild to moderate medial or lateral instability	• Thermoplastic • Carbon graphite options are also available and may be used with a FO, UCBL or SMO for more foot alignment support	• **Swing** toe clearance (concentric simulation of dorsiflexors) • **Stance** loading response (Eccentric simulation of dorsiflexors) and slight tibial forward inclination resistance based on design (eccentric simulation of gastrocnemius and soleus) • Stabilizes foot/ankle complex in sagittal and transverse planes
 Photo courtesy of Children's Healthcare of Atlanta	Articulating Ankle Foot Orthosis (AAFO) with dorsiflexion (DF) assist / plantarflexion resist	• Mild drop foot / slap with medial and/or lateral instability	• Thermoplastic	• **Swing** toe clearance (Simulates concentric contraction of pretibial muscles) • **Stance** loading response (Eccentric simulation of dorsiflexors) • Concentric simulation of tibia advancing forward from end of loading response to past mid-stance. • Provides transverse and medial and lateral stability of the foot and ankle complex
 Photo courtesy of Children's Healthcare of Atlanta	Articulating Ankle Foot Orthosis (AAFO) with plantar flexion (PF) stop	• Toe walking • Mild to moderate genu recurvatum not associated with significant spasticity • Moderate to severe mediolateral (M/L) instabilities of foot/ankle	• Thermoplastic with plastic/ rubber/ or metal joints	• **Swing** toe clearance • **Stance** Provides transverse and medial/lateral stability of the foot and ankle complex • Encourages knee flexion moment in initial contact to mid-stance
	Best if patient has strong voluntary controlled gastrocnemius / soleus muscles and quadriceps			

 Photo courtesy of Children's Healthcare of Atlanta	Articulated AFO with adjustable joints	• The sagittal alignment of the ankle joints can allow free motion, stops or dynamic springs to simulate eccentric / concentric muscle actions.	• Thermoplastic, carbon, or metal/ leather with metal joints • Not often utilized with children because of increased weight, bulk, maintenance, and cost associated with the ankle joints	• **Swing** Toe clearance • Provides transverse and M/L stability of the foot and ankle complex • **Stance** Can be set up in multiple configurations to match the patient's needs and uneven terrain • Provides M/L stability of the foot and ankle complex • Can resist excessive knee flexion and ankle DF
 Photo courtesy of Children's Healthcare of Atlanta	Solid Ankle Foot Orthosis (SAFO)	• Moderate to severe hypertonia/ spasticity • Severe rheumatoid arthritis of foot and ankle	• Thermoplastic or carbon	• **Swing** toe clearance • **Stance** Provides transverse and M/L stability of the foot and ankle complex • Helps stabilize the knee with resisting hyperextension or knee buckling (Shank to vertical angle dependent)
 Photo courtesy of Children's Healthcare of Atlanta	Floor Reaction Ankle Foot Orthosis (FRAFO) with the ankle in slight plantar flexion ankle alignment	• Weak quadriceps or gastrocnemius/ soleus muscle groups	• Thermoplastic or carbon	• **Swing** Toe clearance • **Stance** Decreases the crouch gait or knee buckling. Keeps torso vertical and center of mass in middle over the foot. Accommodate ankle, knee and/or hip flexion contractures[6] • Provides transverse and M/L stability of the foot and ankle complex

 Photo courtesy of Children's Healthcare of Atlanta	Floor Reaction Ankle Foot Orthosis (FRAFO) for crouch gait[7,8]	• Lower-level paraplegia (Spina bifida /Spinal Cord Injury (SCI) associated with hip and/or knee flexion contractures or dorsiflexion contractures • Spasticity associated with hamstrings/knee flexion contractures	• Thermoplastic or Carbon	• **Swing** toe clearance • **Stance** Provides stability to stand while accommodating contractures or weakness • Provides medial and lateral support in coronal plane • **Side note:** Transverse rotation control with AFO/SMO/ shoe-torsion straps/cables are often beneficial for support and balance for rotational instabilities[9]
 Photo courtesy of Children's Healthcare of Atlanta	Knee Ankle Foot Orthosis (KAFO)	• Low thoracic/high lumbar level paraplegia • Severe knee hyperextension • M/L instability for medial tibial plateau in Blounts disease	• Thermoplastic, carbon and metal • Metal uprights and joints with locking/ unlocking options • Stance control options that allow free motion knee joints in swing/ locked in stance	• **Swing** Toe clearance. M/L stability for the knee/ ankle in preparation for initial contact • **Stance** AFO section provides M/L stability of the ankle, ground reaction forces on the knee. • Knee joint & thigh extension provide M/L knee support • Locked knee joint option provides maximal sagittal plane support but unlock for sitting • Microprocessor control for larger teenagers
 Photos courtesy of Children's Healthcare of Atlanta	Hip Knee Ankle Foot Orthosis (HKAFO)	• Thoracic level paraplegia associated with spina bifida, SCI, spinal muscular atrophy (SMA), or muscular dystrophies • Cerebral palsy (typically GMFCS level III, IV)	• Thermoplastic, carbon, and metal • Metal uprights and joints with locking/ unlocking options	• **Swing** Toe clearance, prevents scissoring (swing to, or swivel type gait needed) • **Stance** Maximum support for lower extremities and torso with locking knee and hip joints • Option to unlock knees and/or hips as functionally desired and for sitting • Upper extremity strength and support from walkers or loftstrand crutches is required

 Photo courtesy of Children's Healthcare of Atlanta	Reciprocating Gait Orthosis (RGO) Hip Knee Ankle Orthosis	• Low-thoracic to mid-lumbar paraplegia • Must have good upper extremity and cognitive abilities.	• Thermoplastic, carbon, and metal • Metal uprights and joints with unlocking and locking into reciprocal action	• **Swing:** Allows reciprocal gait motion in ambulation for people with weak to no hip flexors. Prevents scissoring • **Stance:** Supports legs and trunk when there is no or poor trunk control • Upper extremity strength and support from walkers or lofstrand crutches is required • Not recommended for people with significant contractures, poor cognition, poor body awareness or weak upper extremities

UPPER EXTREMITY ORTHOSES

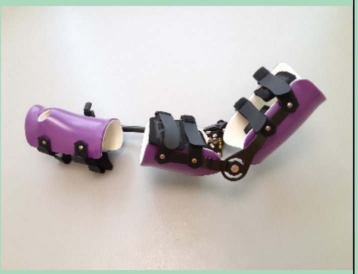
Common Terms:

- Hand Orthosis (HO)
- Wrist Hand Orthosis (WHO)
- Wrist Hand Finger Orthosis (WHFO)
- Elbow Orthosis (EO)
- Elbow Wrist Hand Orthosis (EWHO)
- Shoulder Orthosis (SO)
- Shoulder Elbow Wrist Hand Orthosis (SEWHO)
- Fracture Orthoses

Upper extremity orthoses can be categorized with the following purposes: post-surgical/post-injury support, positioning/range of motion support, and functional control utilizing existing muscles or using external power.

TABLE 2: Upper-Extremity Orthoses and Indication

EXAMPLE	ORTHOSIS	PATIENT PRESENTATION	MATERIALS/ DESIGN OPTION	BIOMECHANICAL PRINCIPLES
 Photo courtesy of Children's Healthcare of Atlanta	HO/WHO/ WHFO	• Spastic flexion • Ulnar deviation • Limited strength or ability to be in a functional position	• Neoprene • Thermoplastic • Metal (support) • Metal supports or joints • Dynamic assist (springs, motors)	• Provides compression and 3-point pressure to optimize alignment/ contracture control. • Aids in function with external support

 Photo courtesy of Children's Healthcare of Atlanta	Elbow Orthosis (EO)	• Flexion/ extension contracture control • Ligamentous instabilities • Self- injury prevention	• Neoprene • Thermoplastic • Metal (support or joints)	• Provides compression and 3-point pressure to optimize alignment/ contracture control • Limit elbow flexion to prevent self-injury • May be combined with a WHO to control supination/ pronation or wrist/hand motions
 Photo courtesy of Children's Healthcare of Atlanta	Shoulder Orthosis (SO)	• Post-Operative/ Injury	• Fabric • Foam • Metal supports	• Limits motion or holds shoulder in specific tri-planar alignment to allow proper healing
 Photo courtesy of Children's Healthcare of Atlanta	Shoulder Elbow Wrist Hand Orthosis (SEWHO)	• Post-Operative/ Injury	• Fabric • Foam • Metal supports or joints • Dynamic assist (springs, motors)	• Limits motion or holds shoulder in specific tri-planar alignment to allow proper healing or • Functional usage with brachial plexus injury
 Photo courtesy of Children's Healthcare of Atlanta	Humeral / Forearm fracture orthoses	• Post injury/post splinting or casting	• Thermoplastics • Foam	• Promote healing with compression and limited functional usage of the extremity; helps prevent re-fracturing through Wolfe's Law

SPINAL ORTHOSES

Spinal orthoses used in pediatric care can be organized into three types according to their purpose: positioning, injury/post-surgical treatment, and scoliosis treatment. Like lower extremity orthoses, spinal orthoses are named for the body segment they treat:

- Lumboscacral orthosis (LSO) – supports lumbar and sacral regions
- Thoracolumbosacral orthosis (TLSO) – supports thoracic, lumbar, and sacral regions

- Cervicothoracolumbosacral orthosis (CTLSO) – supports cervical, thoracic, lumbar, and sacral regions
- Cervicothoracic orthosis (CTO) – supports cervical and thoracic regions
- Cervical orthosis (CO) – supports cervical region

Positioning

Spinal orthoses can be used for positioning the pediatric patient with trunk weakness or hypotonia. Several options are available:

TABLE 3: Positioning Orthoses and Indication

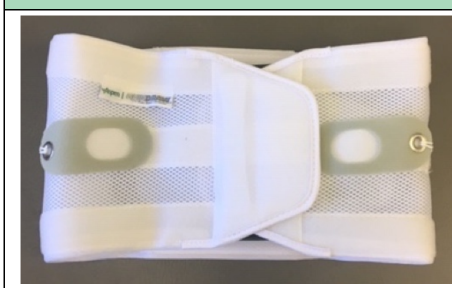
EXAMPLE	ORTHOSIS	PATIENT PRESENTATION	MATERIALS/ DESIGN OPTIONS	BIOMECHANICAL PRINCIPLES
 Photo courtesy of Children's Healthcare of Atlanta	CO	• Lacks head and neck control	• Thermoplastic, soft or firm foam	• Supports cervical spine
 Photo courtesy of Children's Healthcare of Atlanta	Flexible TLSO	• Requires mild support	• Neoprene or spandex, can include rigid panels or stays	• Compresses soft tissues, provides sensory input
 Photo courtesy of Children's Healthcare of Atlanta	Rigid TLSO	• Requires moderate to maximum support	• Thermoplastic frame with soft foam liner	• Provides 3-point forces, aligns trunk in all planes

Injury/Post-surgical Treatment

Spinal orthoses are used post-surgically or following injury to immobilize the spine to facilitate healing. Common spine injuries requiring orthotic treatment include vertebral fractures, ligamentous injuries, muscle strains and back pain. A wide range of spinal orthoses are used to treat pediatric injuries, depending on the injury level and desired biomechanical controls:

TABLE 4: Injury/Post-Surgical Orthosis and Indication

EXAMPLE	ORTHOSIS	PATIENT PRESENTATION	MATERIALS/ DESIGN OPTIONS	BIOMECHANICAL PRINCIPLES
 Photo courtesy of Children's Healthcare of Atlanta	CO	• Spinal injuries occurring from C1 to C6	• Thermoplastic with soft pads, soft or firm foam	• Provides tri-planar control of cervical spine
 Photo courtesy of Children's Healthcare of Atlanta	CTO	• Spinal injuries occurring from C1 to T6	• Thermoplastic chest section with rigid extension for head and neck support, halo for unstable injuries	• Provides tri-planar control of cervical and upper thoracic spine to off-load injury site

 https://spinaltech.com/custom-spinal-braces	CTLSO	• Spinal injuries occurring from C1 to L4	• Thermoplastic TLSO with rigid extension for head and neck support	• Provides tri-planar control of entire spine to off-load injury site
 Photo courtesy of Children's Healthcare of Atlanta	TLSO	• Spinal injuries occurring from T7 to L5	• Rigid thermoplastic frame with foam liner, often bivalve design for safe donning using log roll technique, softer fabric designs for mild muscular injuries	• Provides tri-planar control of thoracic to sacral spine to off-load injury site
 Photo courtesy of Children's Healthcare of Atlanta	LSO	• Spinal injuries occurring from L1 to L5	• Semi-rigid thermoplastic, fabric, corset-style	• Provides tri-planar control of lumbar spine to off-load injury site, provides compression, reduces or increases lumbar lordosis

Scoliosis Treatment

Scoliosis in the pediatric patient is commonly treated with a TLSO. According to the Scoliosis Research Society (SRS), orthotic treatment is recommended for patients whose curves measure 20- to 40-degrees during their growth phase. The goal of orthotic treatment in scoliosis is to prevent the curve from worsening. Treatment consists of routine orthotic and orthopedic follow-up visits to monitor curve progression and growth. Orthotic treatment typically continues until skeletal maturity. Although orthotic treatment may be used for curves of a neuromuscular nature, it is primarily used for idiopathic curves. Idiopathic scoliosis may be infantile, juvenile, or adolescent, all of which could potentially be treated with an orthosis.

The most common group of patients treated with an orthosis fall into the adolescent idiopathic scoliosis (AIS) category. Orthotic treatment for adolescent idiopathic scoliosis has been strongly supported by the results of the Bracing in Adolescent Idiopathic Scoliosis Trial (BrAIST).[10] In this study, the authors concluded that bracing significantly decreased the progression of high-risk curves to the threshold for surgery in patients with AIS. This benefit increased as hours of brace wear increased.

Bracing for scoliosis may be considered part-time or full-time. Part-time TLSOs are often worn only at night. Nocturnal designs include the Providence TLSO and the Charleston Bending Brace. Full-time TLSOs are worn 18-23 hours per day. Examples include the Boston Brace and the Rigo Cheneau TLSO. While these designs all differ slightly, all scoliosis TLSOs are custom designed for each patient. They work via three-point force systems coupled with derotation forces to straighten the patient's spine as much as possible while the TLSO is being worn.

TABLE 5: Spinal Orthoses

PROVIDENCE TLSO	CHARLESTON BENDING BRACE	BOSTON-STYLE TLSO	RIGO-STYLE TLSO
			
Photo courtesy of Children's Healthcare of Atlanta	https://cbb.org/braces/	Photo courtesy of Children's Healthcare of Atlanta	Photo courtesy of Children's Healthcare of Atlanta

Physical therapists can be an important part of the treatment team for scoliosis in pediatric patients. There are many schools of scoliosis-specific exercises, including the Schroth Method. In addition to providing exercises to specifically address patients' curve patterns and clinical presentations, physical therapists can play a vital role in helping patients learn to complete ADLs while wearing their orthoses.

While there continues to be gaps in research on orthotic treatment of scoliosis, many studies show promising results of bracing and identify indicators for treatment success. Multiple studies, including the BrAIST study and a study by Karol et al.[11] found that increased wear time correlated with less curve progression. This indicates patients with higher risk of progression might be better treated with a full-time brace. A study by Thompson et al.[12] of patients using the Boston style TLSO identified main lumbar curves as less likely to worsen than main thoracic curves. A study of the Cheneau brace by Korovessis et al.[13] found a high rate of treatment success of various curve types with only 6.8% of the study's patients undergoing surgery. A study of the Providence nighttime brace by Davis et al[14] identified a Risser score greater than or equal to 1 and a curve apex of T10 and lower as predictors of successful treatment with the Providence brace. Likewise, in a study of the Providence nighttime brace by Simony et al.,[15] the authors found an 89% success rate, with results comparable to full-time treatment with the Boston brace. They identified high in-brace correction as important in part-time bracing.

Pectus Carinatum

Orthotic treatment may also be used to treat adolescents with pectus carinatum. This chest wall protrusion deformity is treated with a compression orthosis that consists of a rigid frame with anterior and posterior pads. The frame is tightened with straps or buckles to provide a compressive force to the pliable chest wall. Pectus carinatum orthoses are typically worn 18-23 hours per day until a patient has completed most of their growing.

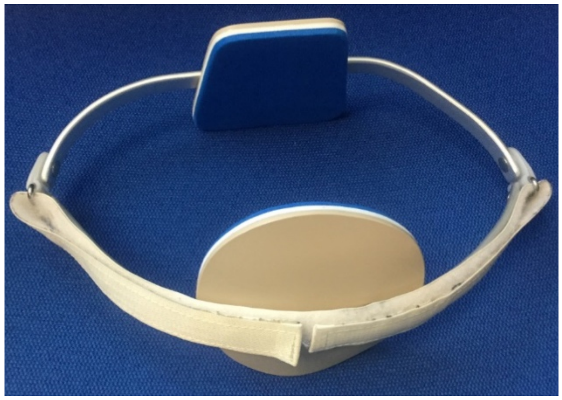


Photo courtesy of Children's Healthcare of Atlanta

CRANIAL REMOLDING ORTHOSES

Refer to the APTA Academy of Pediatrics fact sheet on Deformational Non-Synostotic Head Shapes.

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