FACT SHEET

SECTION ON PEDIATRICS

AMERICAN PHYSICAL THERAPY ASSOCIATION

Foundations of Pediatric Orthotics

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 is an external device with controlling forces 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 have formal education in biomechanics and material sciences required in designing custom devices. They are nationally board certified, and 11 states require licensure to provide custom devices. There are approximately 3,000 certified orthotists in the US, with a limited number of orthotists specializing in pediatrics. Pediatric orthotists evaluate the child, cast the child, modify the mold, fabricate the orthosis, and custom fit the orthosis to the child.

- Physical therapists are trained in the function of orthoses and will frequently fit and measure orthoses. If the child is measured by the physical therapist, the orthoses are usually centrally fabricated and returned to the therapist for custom fitting and delivery. Following delivery of the orthosis, physical therapists provide education and functional training to the child and family. Some physical therapists fabricate and fit low-temperature orthotic devices/splints, requiring training beyond their basic education.

- Physicians, orthotists, and physical therapists often provide simple, off-the-shelf devices for acute situations. The sizing of these devices is determined by measurement and does not require custom fitting.

- Families can purchase supports and braces at pharmacies and sport stores.

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Who Is on the Team?

A team approach is always recommended for optimal outcomes. The rehabilitation team should include physicians, orthotists, physical therapists, occupational therapists, social workers, and, most importantly, the child and family. Physical therapists working with the child and family in schools and community rehabilitation settings play an integral role in developing the orthotic prescription.

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 child's current and future needs. Considerations include cost as well as adjustability of the device to meet the child's changing needs.

What Are the Characteristics of Pediatric Lower-Extremity Orthoses?

Design

- Lower-extremity orthoses are specifically designed for the child's functional needs, whether ambulatory or non-ambulatory, with considerations of 3-point force systems and ground reaction forces to control alignment in all 3 planes.

- Additional benefits of orthoses may include controlling or limiting joint movements, simulating an eccentric or concentric muscle function, increasing range of motion, and providing proprioceptive feedback. This is achieved by incorporating mechanical joints, springs, or flexible materials into the orthotic design.

- Transverse rotation control of the lower extremities (hips, knees, tibial torsion) requires the child to wear torsion cables or metal uprights with a hip/waistband/belt or elastic twister straps and waistbelt.

- Lower-extremity devices should optimize leverage for control without resisting desired range of motion for activities or causing internal complications (eg, peroneal nerve palsy).

- Orthoses may be initially fabricated to provide maximum stability and then be adjusted for less stability and more voluntary control as the child progresses.

- Designs and colors have greatly improved wearing adherence by allowing the child to personalize and have a choice in designing the orthosis.

Materials

- There are numerous types and thicknesses of materials to choose from when fabricating an orthosis. Selection of brace design and the appropriate material and design of the brace is essential for function, strength, durability, flexibility, comfort, adjustability, compliancy, hygiene, and skin integrity.

- Most orthoses are made from vacuum-molded thermoplastics. Plastic thicknesses can vary between 1/16" to ¼". Occasionally, metal/leather 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 need:

- 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

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 child's limb. This increases stability and decreases unnecessary pressure.

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Pads

- Pads are often provided in areas where there are boney 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 force systems in order to improve alignment.
- Pads should never be applied in an area of the brace that is already providing excessive pressure to the child. Even the softest padding will increase the pressure in this area.

Trim Lines

- 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 with utilization of a toe extensor pad for hypertonia, painful 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.
  - Trimming the footplate to stop behind MT heads (rare in children) is indicated for painful 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.
- Trim lines should optimize leverage for control without adding bulk to make clothing or shoe wear hard to fit over the device.

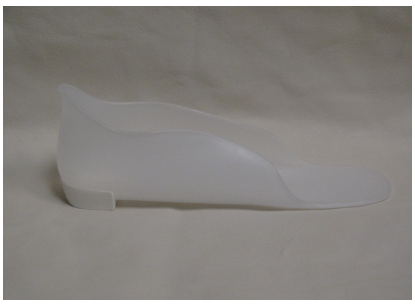
What Type of Shoes Should Be Worn With an Orthosis?

- Shoes should have:
  - Good construction, leather preferred
  - Good heel counter, quality sole
  - A removable insole to increase instep depth
  - ¼"–⅜" heel height
  - Rockered toe
  - Laces or Velcro closure to instep
- The fit of the shoe can affect orthotic function. The clinician can assist the child and family in selecting the proper shoe for the prescribed orthosis.
- The heel height of the shoe can affect the child's standing alignment while in the brace.

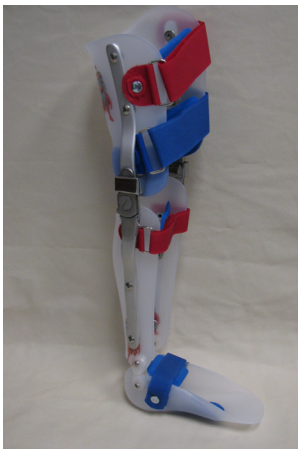
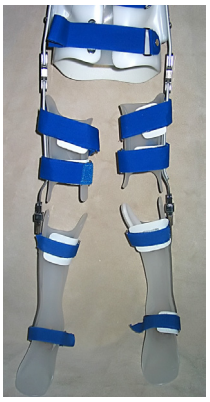
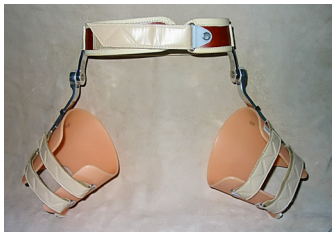
Can an Orthosis Be Used for Contracture Prevention/Reduction?

- Dynamic assistive braces have an adjustable tension-spring assistance mechanical joint to reduce or prevent anatomical joint contractures.
- Static progressive braces hold a stretch with the force applied to the anatomical joint. Increased range may be achieved with increased manual stretch.
- Static braces have no adjustability and hold the limb in one position.
- Custom-made braces provide optimal control in all 3 planes of motion. These are indicated for long-term implications and multiple-plane control.
- Off-the-shelf braces provide adequate control in one plane of motion. There are options for purchase or rental of some braces. They are less durable than custom made and indicated for acute conditions of limited range of motion.
- Acute conditions with soft-end ranges and good skin integrity benefit from off-the-shelf styles.
- Chronic conditions or certain situations (eg, high tone/spasticity, soft-to-hard end ranges, good to poor skin integrity, a child who has periods of being agitated) should be fitted with custom braces. The cost advantage is beneficial in these situations compared to multiple serial casts.
- Other interventions for control also should be considered (eg, serial casting, anti-spasticity medications, electrical stimulation).
- Adherence of the device regimen is essential for success.

Lower-Extremity Orthoses and Indication in the Gait Cycle

Photo of the orthosis	Device & Condition	Stance Phase (Indications)	Swing Phase (Indications)
	Foot Orthosis (FO)	Arch alignment	none
	UCBL, University of California Biomechanics Laboratory Plantar fasciitis, excessive pronation, metatarsus adductus	Stabilizes foot/ankle complex in sagittal and transverse planes	none
	Supra Malleolar Orthosis (SMO) Severe pronation or supination	Stabilizes foot/ankle complex in sagittal and transverse planes	Resists excessive inversion/eversion (for safer initial contact)
	Posterior Leaf Spring (PLS) Ankle Foot Orthosis (AFO) Drop foot, peroneal palsy with minimal to no medial or lateral instability	Flexible posterior allows simulated eccentric contraction of pre-tibial muscles to prevent foot slap. A UCBL foot plate will offer medial and lateral (M/L) foot and ankle stability	Swing clearance
	Articulating Ankle Foot Orthosis (AAFO) with dorsiflexion (DF) Assists joints with DF. Mild drop foot with medial and lateral instability	Simulated eccentric contraction of pre-tibial muscle to prevent foot slap. Provides good transverse and medial lateral stability of the foot and ankle complex. Allows DF and advancement of the contralateral limb	Simulated concentric contraction of pre-tibial muscles Provides transverse and medial and lateral stability of the foot and ankle complex

	Articulating Ankle Foot Orthosis (AAFO) with plantar flexion (PF) stop Toe walking, mild to moderate genu recurvatum, moderate to severe M/L instabilities of foot/ ankle	Encourages knee flexion moment at initial contact through midstance. Provides transverse and M/L stability of the foot and ankle complex. Allows DF and advancement of the contralateral limb	Swing phase clearance Provides transverse and medial/lateral stability of the foot and ankle complex
	Solid Ankle Foot Orthosis (SAFO) Severe hypertonia, severe rheumatoid arthritis of foot and ankle	Encourages knee flexion moment in initial contact to mid-stance. Resists excessive knee flexion and ankle DF. Provides M/L stability of the foot and ankle complex	Swing phase clearance Provides transverse and M/L stability of the foot and ankle complex
	Floor Reaction Ankle Foot Orthosis (FRAFO) with the foot in neutral slight plantar flexion Weak quadriceps muscles with no M/L knee instability	Encourages knee extension moment to prevent knee forward buckling. Provides M/L stability of the foot and ankle complex	Swing phase clearance More difficult going up hills Provides transverse and M/L stability of the foot and ankle complex
	Floor Reaction Ankle Foot Orthosis (FRAFO) for crouch gait Lower-level paraplegia associated with hip and knee flexion contractures	Decreases the crouch gait and keeps torso vertical and center of mass in middle of the foot. Provides transverse and M/L stability of the foot and ankle complex	Swing phase clearance

	Knee Ankle Foot Orthosis (KAFO) Low thoracic/ high lumbar level paraplegia, severe knee hyperextension, M/L instability at the knee, Blounts disease	AFO section provides M/L stability of the ankle, swing phase control, ground reaction forces on the knee. Knee joint & thigh extension provide M/L knee support. Locked knee joints option provides maximal sagittal plane support but unlock for sitting	Swing phase clearance M/L stability for the knee in preparation for initial contact
	Hip Knee Ankle Foot Orthosis (HKAFO) Paraplegia	Maximum support for lower extremities in all 3 planes and lower torso	Swing phase clearance Prevents scissoring
 Photo courtesy of Liberating Technologies	Reciprocating Gait Orthosis (RGO) Hip Knee Ankle Orthosis Mid-thoracic to high-lumbar paraplegia	Maximum support for lower extremities and lower torso	Swing phase clearance Assists in advancement of the lower limbs
 Picture from www.camphealthcare.com	Standing-Walking and Sitting Hip Orthosis (SWASH)™ Low to moderate adductor tone	Prevents scissoring. Allows for sitting. Stabilizes the hip post-surgically	
	Legg-Calf-Perthes	Encourages proper blood flow to the femoral neck and head	

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WEB SITES

Surestep–Dynamic Stabilizing System: **www.surestep.net**

Ultraflex: **www.ultraflexsystems.com**

Cascade DAFO: **www.cascadedafo.com**

For More Information:

If you have additional questions, would like to order additional copies of this fact sheet, or would like to join the Section on Pediatrics, please contact the Executive Office of the Section on Pediatrics of the American Physical Therapy Association at: APTA Section on Pediatrics, 1111 North Fairfax Street, Alexandria, VA 22314, pediatrics@apta.org, www.pediatricapta.org.

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