Technical Note

Orthotic Pelvis Control in Spina Bifida

by H.R. Lehneis, Ph.D., C.P.O.

Control of the pelvis has been typically problematic in high level spina bifida patients due to the imbalance of motor power around the hip joint. This can be readily appreciated when one considers the differential innervation particularly of the hip flexors versus the hip extensors (Table 1). Note that the hip flexors are at least partially innervated at the L2 and L3 level, whereas the hip extensors are innervated below the L3 level. Such imbalance at the L2 and L3 level of involvement is the cause of lordosis so often seen in these patients, which is often aggrevated by hip flexion contractures. Control of the pelvis and thus lordosis has been difficult with conventional designs.

In analyzing the force system required to prevent hip flexion and thus lordosis, it becomes clear that the rigid portion of the pelvic band needs to be reversed from the conventional location (Figure 1). It should be noted that this consists of a plastic molded Subortholen panel which extends superiorly to the level of the xyphoid process. The uprights of the hip joints are attached to this panel. An anteriorly directed force is provided by a leather hammock covering the buttocks (Figure 2). Straps attached on each of the four corners of the hammock run through D rings, attached equi-distant above and below the orthotic hip joint center. This system has worked quite effectively in controlling lordosis since first initiated approximately five years ago.

In cases where the patient presents a relatively severe hip flexion contracture, the hip joint uprights are attached to the panel by means of a single pivot placed approximately 5 cm. below the lateral trim line of the panel. By gradually tightening the straps of the buttock pad, some correction can often be achieved. The pivot allows the anterior panel to adapt to the changing angulation as correction is attempted.

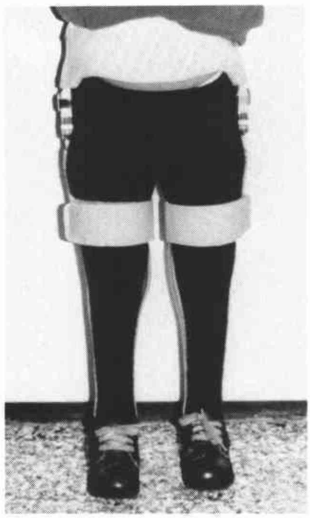

Figure 1.

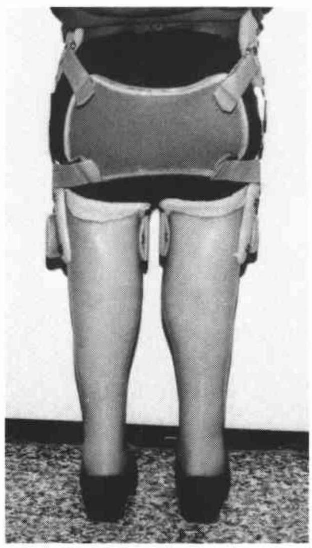

Figure 2.

Innervation of Muscles of Lower Limb

	Muscle	Spinal Cord Segment							
		L1	L2	L3	L4	L5	S1	S2	S3
Peripheral Nerves of Lumbosacral Plexus	Iliacus		■	■	◧				
	Psoas Major	◨	■	■	◧				
	Psoas Minor	■	◧						
	Gluteus Maximus				◨	■	■	■	◧
	Gluteus Medius				■	■	■		
	Gluteus Minimus				■	■	■		
	Tensor Fascia Latae				■	■	■		
	Piriformis					◨	■	■	
	Gemellus Superior					■	■	■	
	Gemellus Inferior				■	■	■		
	Quadratus Femoris				■	■	■		
	Obturator Internus					■	■	■	
O	Obturator Externus		◨	■	■	◧			
O	Adductor Longus		◨	■	■				
O	Adductor Brevis		◨	■	■	◧			
O + S	Adductor Magnus		◨	■	■	◧			
O	Gracilis		◨	■	■	◧			
F	Quadriceps Femoris		■	■	■	◧			
F	Sartorius		■	■	◧				
S	Semitendinosus				◨	■	■	■	
S	Semimembranosus				◨	■	■	■	◧
S	Biceps Femoris				◨	■	■	■	■
T	Popliteus				◨	■	■	■	
P	Tibialis Anterior				■	■	■		
P	Extensor Hallucis Longus				■	■	■		
P	Extensor Digitorum Longus				■	■	■		
P	Peroneus Tertius				■	■	■		
P	Peroneus Longus				■	■	■		
P	Peroneus Brevis				■	■	■		
T	Gastrocnemius					◨	■	■	
T	Soleus					◨	■	■	
T	Tibialis Posterior					■	■		
T	Flexor Hallucis Longus					■	■	■	
T	Flexor Digitorum Longus					■	■	◧	
P	Extensor Digitorum Brevis				◨	■	■		
P	Extensor Hallucis Brevis					■	■		
T	Abductor Hallucis				■	■	◧		
T	Abductor Digiti Minimi						■	■	
T	Flexor Digitorum Brevis				■	■	◧		
T	Quadratus Plantae						■	■	
T	Lumbricales				■	■	■	■	
T	Flexor Hallucis Brevis				■	■	■		
T	Adductor Hallucis						■	■	
T	Interossei						■	■	

Key to Peripheral Nerves:
F = Femoral N.
O = Obturator N.
S = Sciatic N.
T = Tibial N.
P = Peroneal N.

Table 1

It should also be noted that in our practice, patients up to the age of approximately six years old are provided with solid ankles and knees since their legs are still short enough to sit through hip flexion without obstructing much of the space in front of the chair. The purpose of this is to provide the patient with maximum stability and lightweight orthoses. As the patient gains upper limb strength and mobility, knee joints with drop locks are added, usually of the lateral single bar type. Double bars are only used when the patient is relatively heavy and when there is a torsional problem in the orthosis. The ankle-foot portion of the orthosis remains of the solid ankle type to provide the largest possible base of support over which the patient's center of gravity can be maintained with a greater degree of latitude than is possible if orthotic ankle joints were to be used.

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Rigid A.F.O.—Another Choice

by Robert E. Doran, C.P.O.*

When an orthotic prescription calls for an ankle/foot orthosis to provide rigid ankle/foot stabilization, the two basic choices have been (1) a double bar metal orthosis or (2) a thick and/or reinforced thermoplastic orthosis. We are all familiar with the advantages and disadvantages each has to offer.

It was this author's goal to design a rigid A.F.O. that would combine the advantages of both. The features of such an orthosis should include light-weight construction; provide rigid ankle stabilization; provide adjustable plantar and dorsiflexion in order to dynamically align the orthosis; fit inside the shoe; be cosmetically acceptable; be easily donned; and maintain alignment while changing heel heights.

With the above in mind, the following orthosis was designed. The orthosis consists of "pre-preg" (the resin is impregnated in the matrix in an uncatalyzed form prior to lay-up, generally at the factory. Once the desired lay-up is achieved, the structure is exposed to a catalyzing agent so that it hardens), carbon-fiber and fiberglass fabric. Epoxy and polyester resin have been used as bonding agents and the orthosis is formed over a plaster model of the patient's leg. Such pressure applying agents as vacuum bags and pressure wraps have been used. The carbon fiber and fiberglass fabric are properly oriented to resist the stresses imposed upon the orthosis and comprise a structure that provides a high strength to weight ratio.

The orthosis has a foot section which begins on the plantar aspect of the foot and extends proximally on the medial and lateral sides of the leg. The "uprights" are connected by adjustable velcro-closing calf straps. Plantar and dorsiflexion adjustments are independently achieved by adjusting the anterior and posterior velcro-closing calf straps (see Figures 1-3).

In some cases, donning is simplified by removing the posterior strap, thus allowing for a posterior entry of the foot and leg into the orthosis and shoe.

Over the past eighteen months, nine patients with diagnoses that include low level paraplegic, C.V.A., and neuromuscular disease have been fitted with the graphite composite A.F.O. as a successful alternative to "traditional" orthoses.

Orthotists now have another choice when designing a rigid ankle foot orthosis for their patients. The graphite composite A.F.O. combines some of the advantages of the standard metal and thermoplastic constructed A.F.O.

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