Effects of Ankle-Foot Orthoses on Functional Motor Performance in a Child With Spastic Diplegia

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A pilot case study examining the effects of inhibitive ankle-foot orthoses on functional motor performance in a child with spastic diplegia is presented. Both qualitative and quantitative changes occurred, lending support to the efficacy of inhibitive orthoses in improving motor performance in children with cerebral palsy.

Inhibitive casts and inhibitive orthoses have been recommended as adjunctive treatment strategies for a variety of types of patients with central nervous system deficits. King (1) reported on the serial use of plaster drop-out splints to reduce flexor spasticity in the left upper extremity of a woman with left hemiparesis secondary to a cerebral vascular accident. Basing his ideas on the work of Moore (2) and Scholz and Campbell (3), King theorized that the reduction in spasticity which occurred in this patient following splinting was due in part to an inhibition of the spastic elbow flexors from "the autogenic inhibitory response of the Ib afferent fibers serving the golgi tendon organs" (1, p. 671). The use of a tone-inhibiting lower extremity orthosis for a 25-year-old patient with head injuries was described by Zachazewski and colleagues (4). These investigators reported gait improvements such as decreased positive support responses and increased heel strike while the patient was wearing the orthosis (4).

Inhibitive casts and inhibitive orthoses also have been recommended for use with children with cerebral palsy (5, 6). Inhibitive casts have been advocated specifically as an adjunct to the neurodevelopmental treatment (NDT) approach for the purposes of reducing extensor thrust and facilitating supported or independent standing, cruising, and walking (7). Others have suggested that inhibitive casting appears to reduce reflex-induced foot deformities and hyper tonus in children with cerebral palsy (8).

While descriptive articles advocating the use of inhibitive casts or inhibitive splints have appeared in the recent therapy literature (5-8), no data-based reports have been published examining the efficacy of these adjunctive treatment strategies. In an effort to justify the use of such costly modalities as part of the treatment regimen for children with cerebral palsy, we have studied and reported their application with two children in our clinic population. One study described the use of upper extremity inhibitive casts in preventing progression of elbow flexion contractures in a child with severe spastic quadriplegia (9); the second study focused on the effects of lower extremity inhibitive orthoses in improving standing balance in a child with moderate spastic quadriplegia (10). The following is a brief report describing the effects of inhibitive ankle-foot orthoses on functional motor performance in a child with spastic diplegia.

Subject

The subject is a boy, 6 years and 3 months old, with spastic diplegia. He has been receiving developmental therapy from our clinic since the age of 13 months. There is greater spasticity on the left as evidenced by passive motion in hip adductors and posture in stance (greater internal rotation, hip and
knee flexion, and equinus on the left). Fine motor skills are within normal limits. Yet difficulties in visual-motor tasks such as accurate tracing and cutting have been reported. Corrective eye surgery for amblyopia was conducted when the subject was 4 years and 10 months old.

The subject was first fitted for inhibitive plaster casts at the age of 2 years. He continued to wear either shoe boots or long-leg cast boots until the age of 5 years when inhibitive ankle-foot orthoses were fabricated for him. The rationale for changing from plaster casts to plastic splints was based on three factors: (a) the subject had outgrown the cast boots, (b) he was attending an integrated public preschool, which included more playground and outdoor activities, and (c) the plastic orthoses fits inside regular shoes and is less visible.

The subject's most recent ankle-foot orthoses were made when he was 5½ years old. For the subject's new orthoses, a plaster negative mold was made by an orthotist and the subject's occupational therapist (11). The height of the orthosis is approximately midcalf on the right and slightly higher on the left. Straps hold the great toe in a position of neutral alignment rather than in valgus (see Figure 1). The subject wears his orthoses every day from morning until evening (approximately 10 to 12 hours per day). In addition to attending the regular school program, he continues to receive occupational therapy for 1 hour a week at our clinic, and he also receives twice-weekly therapy sessions at the school.

Procedures
To assess possible functional differences in the subject's motor performance with and without the inhibitive ankle-foot orthoses, we evaluated the subject in three different activities during treatment (boy wearing orthoses) and without treatment (boy not wearing orthoses).

The first activity assessed the subject's standing balance. The results of a pilot study with another child treated in our clinic (10) led us to hypothesize that the subject would be able to stand for a longer time with the orthoses than without them. The subject was videotaped for five sessions during a 5-week period. Each session consisted of five timed trials with the boy wearing the orthoses and five timed trials with the boy not wearing the orthoses. During the trials, the subject was asked to stand for as long as possible while the therapist timed the duration of independent standing.

The second activity assessed the subject's ability to catch a 10-inch rubber ball thrown from a distance of 6 feet while he was maintaining his standing balance. Two videotaped sessions of this activity for the treatment and no-treatment conditions were completed over a 2-week period.

Results
On the standing balance and ball-catching activities, no quantitative differences were noted between the two treatment conditions. The duration of standing balance was the same both with and without orthoses, as was the frequency of successes in catching the ball. However, qualitative differences became apparent when the prerecorded videotapes were analyzed. During both activities, the subject demonstrated improved foot positioning while wearing the orthoses; he was able to bear weight on the ball of his foot on the left whereas without the orthoses he was completely up on his toes in an equinus position on the left. While the subject was wearing the orthoses, his right heel was flat on the floor in a plantigrade position; without the orthoses, his right heel did not touch the floor during standing.

There was greater external rotation and abduction on the left hip with the orthoses; this resulted in a more symmetrical stance pattern with more even separation of the hips. The subject's toes were more extended while he was wearing the orthoses. This suggested a decreased positive support response since the subject's toes were constantly flexed while he was standing without the orthoses. These findings

Figure 1
Ankle-Foot Orthoses

The final activity evaluated the subject's performance on the fine-motor portion of the Peabody Developmental Motor Scales (12). Initially, as part of his routine annual therapy evaluation, the subject completed the Peabody Fine-Motor Scale while wearing his ankle-foot orthoses. Three weeks later, the subject completed the same scale without orthoses. Both tests were scored several days after the second testing.
are similar to those of Zachazewski and colleagues (4), but unfortunately it was impossible to quantify them systematically.

Upper extremity differences were also noted in the videotape analysis. During the standing balance activity without orthoses, the arms assumed a primitive "high-guard" position with shoulders abducted, elevated, and externally rotated. With the orthoses, the upper extremities were held at the side or abducted slightly for balance.

On the Peabody Fine-Motor Scale, the subject's test performance was better when he was wearing the orthoses even though he was 3 weeks younger during the initial test session and had had no opportunity to practice the test items (see Table 1). His developmental motor quotient was within normal limits in two of three areas during the session in which the orthoses were worn. The developmental motor quotients during the second administration were below those of the first test session and below one standard deviation from the mean for all three areas. These results are congruent with those of Scheuermann (13) who demonstrated that the fine motor performance in five of six children with spastic cerebral palsy improved when they were wearing inhibitive lower extremity casts.

Discussion

The lack of support in the literature for tone-reducing casts or splints may seem, in part, from difficulties in reliably measuring muscle tone in a clinical setting. This pilot case study is an attempt to demonstrate accountability for our treatment activities by documenting some qualitative and quantitative changes in motor performance that are possibly attributable to inhibitive ankle-foot orthoses. The study was carried out in a clinical setting, and standard subjective and objective measures of clinical performance were used. Despite its limitations, this study might serve as an impetus for further research in examining the efficacy of inhibitive casts and inhibitive orthoses in improving motor performance among children with cerebral palsy. More studies are warranted as these adjunctive treatment strategies continue to gain in popularity among pediatric occupational and physical therapists.

References


### Table 1

<table>
<thead>
<tr>
<th>Eye-hand coordination</th>
<th>Session I (with orthoses)</th>
<th>Session II (without orthoses)</th>
</tr>
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<tr>
<td></td>
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<td>69</td>
</tr>
<tr>
<td>Manual dexterity</td>
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<td>79</td>
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<tr>
<td>Total score</td>
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</tbody>
</table>

*Note: Peabody Developmental Motor Quotient. X = 100; SD = 15.*