A Strapping Case Study

LINKING NDT WITH THERATOGS™ STRAPPING SYSTEM AND OTHER ORTHOTICS

BY MARLENNE G. BURT, MS, PT

Therapists want to make the most of their treatment sessions and follow through with home programs that are meaningful for functional change. As therapists who work with children with complex posture and movement disorders using the NDT Approach, we constantly struggle with how best to help children practice more functional movements introduced in therapy sessions when they are not directly under our guidance. This case study details both the active posture and movement work done in a series of physical therapy sessions with one child and management outside of scheduled therapy sessions.

Francheska is a five-year, nine-month old girl who has a diagnosis of spastic diplegic cerebral palsy. She underwent selective dorsal root rhizotomy at the age of five years, one month. Currently, her functional skills place her at Level II on the Gross Motor Functional Classification System (GMFCS) (Palisano 1997).

PHYSICAL THERAPY EVALUATION

A condensed version of her physical therapy evaluation findings focus on posture and movement that pertain to stance and gait. Francheska's postural alignment in standing shows that her base of support (BOS) has inadequate support surface contact and that she has difficulty aligning her center of mass (COM) vertically over her lower limbs (**Fig.1**). Her COM is anterior relative to her BOS (**Fig. 2**) and weight load distribution is inappropriate—in the sagittal plane, the weight line is posterior to the knee joint axis and slightly anterior to the ankle joint axis (**Figs. 2 & 3**).

This alignment limits Francheska's movement variety and options because it biases excessive recruitment of flexors and she is required to use excessive isometric and eccentric muscle activity in sustained contractions simply to remain upright. Her COM is anterior to her heels, creating a moment that causes compensatory movements to occur—the overuse of cervical extensors, thoracic flexors, lateral trunk flexors, hip flexors and adductors, knee flexors, and plantarflexors. Such compensation, in turn, requires great effort and risks her stability, making movements to initiate weight shifting for taking a step more difficult. Muscle recruitment timing and order are altered, due to both the damage from the lesion(s) causing her diplegia and from her initial stance-alignment and BOS-biasing muscle activation conditions described previously. Over time and with mass repetitions, this causes muscle groups that are overused to be weakened and shortened and muscle groups that are underused to be weakened and overlengthened. Compensatory muscle contractions in her upper extremities attempt to help her balance, but cost her more energy expenditure.


Fig. 1


Fig. 2


Fig. 3

The muscle groups that she tends to overuse and initially recruit include thoracic flexors, lateral trunk flexors, hip flexors, hip adductors, hip internal rotators, knee flexors, ankle plantar flexors, and toe flexors. Therefore, her gait is characterized by weight shifting initiated by lateral trunk movements over an inadequate BOS with her COM anterior in relation to the BOS and her upper extremities part of her postural holding. All of these impairments and movement compensations limit Francheska's selective movement control and her ability to use well-timed and refined muscle force production, velocity of movement, direction change, and anticipatory postural adjustments.

Francheska's muscle strength is characterized by inadequate force generation in the muscle groups that are overlengthened and their antagonists and synergists. These include the thoracic extensors, scapular adductors and depressors, lumbar extensors, abdominals, hip extensors, hip external rotators, hip abductors, knee extensors, and ankle dorsiflexors. Francheska also has inadequate force generation in muscle groups that are over recruited. These muscles tend to be shortened and used isometrically only, without the necessary controlled concentric and eccentric contractions needed for gait.

Finally, Francheska shows faulty alignment in standing due to changes in soft tissue extensibility and skeletal geometry. The Ryder's test for femoral torsion is positive for excessive femoral antetorsion, left greater than right. Her hamstring length test yields an earlier first catch at initial range bilaterally, left greater than right with a dense quality into the limited end range (-41º/-31º left; -38º/ -25º right). Passive ankle dorsiflexion with knee extension yields a dense first point of resistance on the left at -3º. Maximum end range into right ankle dorsiflexion is 15º. These findings are important to note because they provide a history of longstanding and chronic muscle imbalance and abnormal muscle forces influencing movement strategies, soft tissue, and skeletal modeling. *(continued on page 23)*

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GAIT ASSESSMENT

Details of Francheska gait are based on visual assessment and on footprint analysis with specific measurements taken from the footprint record (**Figs. 4 & 5**). Visually, Francheska uses a lateral trunk flexion lurch to initiate weight shift. This is more pronounced on the right side of her trunk. There is inadequate stance stability and difficulty with foot clearance in swing, left more than right. Her energy cost is high, noted by her lack of heel contact at initial stance, excessive knee flexion from midstance to terminal stance, and decreased propulsion in late stance.


Fig. 4


Fig. 5

Footprint analysis shows that Francheska has a wider BOS than ideal for her age. Her step and stride length are shorter on the left with a medial foot progression angle (in-toe gait), left foot greater than right. Initial contact is mostly with the medial forefoot. There is later weight acceptance on the left foot, and greater pronatory stresses on the left foot.

TREATMENT PLAN

Treatment activities were supported and reinforced by TheraTogs, a latex free, live-in orthotic system. TheraTogs provides a "second skin," along with strapping options, that simulates muscle force couples to improve postural alignment, postural stability, joint stability, and movement skill and precision. The gentle and graded low-load input improves joint, body, and movement awareness, providing feedback. By enhancing optimal posture and movement practice with repetition during meaningful tasks, TheraTogs permits the client to lead the movement and be responsible for the success of its outcome. The child can then utilize his strengths and maximize his efforts so that motor learning can occur.

Electrical stimulation was used for a short period of time but ended because it frightened Francheska. Taping was used periodically before we started with the TheraTogs.

I used handling techniques during movement transitions, addressing postural synergists to optimize postural alignment and a vertical COM relative to the BOS.


Fig. 6

My hands were frequently facilitating the abdominal obliques and transverse, hip abductors and extensors throughout her treatment sessions. We focused on transitions into stand through sit:

- **Stand** (different height chairs and inclines)—kneeling and half kneeling (hands on her waist—frontal plane—facilitating lateral weight shift recruiting thoracic extensors, abdominals, hip abductors and extensors; pt facilitating with arms overhead and forward reaching)
- **Step stance work**—stepping onto different height benches/surfaces with facilitation and having her attempt new weight shifts supporting her efforts in order to increase demand of trunk flexion / rotation, synergistic action of thoracic extensors / latissimus dorsi / oblique and transverse abdominals / hip extensors. **(Fig. 6)**
- **Lateral stepping**—addressing initiation of lateral weight shifts with hip abduction/adduction as child has greater boundaries for weight shift. **(Fig. 7)**
- **Transitions into standing** (variety of ranges) **and stride stance work**—grading tibial progression to decrease knee flexion at midstance and excessive tibial progression as well as focusing on hip extension, knee extension and plantarflexion for push-off possibilities. **(Fig. 8)**
- **Standing work**—practicing shifting of COM over heels off disc, with heel wedge to aid loading her heels
- **Stair climbing**
- **Retro-walking and forward walking carrying a 14' ball**


Fig. 9

Francheska climbed a rock climbing wall with variable routes to encourage thoracic extension, extension/rotation with load-bearing rotation as she placed her externally rotated upper extremities on different height rocks **(Fig. 9)**. Vertical climbing facilitated hip extension and lateral rotation, and push off; horizontal climbing demanded hip abductor/adductor activity at different lengths. Climbing was performed by facilitation of therapists and TheraTogs; TheraTogs only with verbal instructions; and *(continued on page 24)*


Fig. 7


Fig. 8

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TheraTogs only.

Francheska used the treadmill at 1.7 mph for ten minutes three times a week with upper extremities externally rotated and abducted as she held on to a side pole. This assured optimal alignment her COM over her BOS. Focus was to increase step length and optimize push-off capability by increasing knee extension and assisting plantar flexion power aiding swing phase knee extension to increase step length and address rhythmicity and timing of steps.

Strengthening and functional, meaningful activities, including her favorite salsa dancing and playing waitress, were included in all aspects of Francheska's treatment. Addressing frequency and patterns of muscle recruitment influences contractile capacity of muscle; therefore strength is gained through correct and repetitive practice that offers variability for skill acquisition.


Fig. 10


Fig. 11


Fig. 12

An AR-WRAP articulating ankle foot orthosis (AFO) was chosen as an optimal orthosis for Francheska. The AR-WRAP AFO, developed by John Russel, CPO, COCOP (he can be reached at R_john@earthlink.net), is a lightweight, two-piece style articulating AFO that permits a few degrees of ankle dorsiflexion and plantar flexion by providing a total-contact, intrinsic ankle joint. It is imperative not to block plantar flexion at propulsion or you'll reduce step length options by reducing swing phase knee extension. Francheska has been wearing this orthosis all day for four months and reports it has a comfortable fit.

I selected a TheraTogs™ strapping system for the purpose of providing postural alignment, postural stability, and control. It provides somato-sensory information and facilitates motor learning as it allows her to lead the movement, be resonsible for the success of the outcome, and provide practice during meaningful tasks utilizing her strengths and maximizing her efforts.

Francheska has been using TheraTogs approximately five days a week for four hours a day for three months. This schedule was chosen to meet the family's needs and possibilities.

Various strapping options were used, including thoracic extension/ shoulder retraction and spinal extension straps; oblique abdominals and for left pelvic retraction; transverse abdominals; hip lateral rotators/abductors and extensors (**Fig. 10**). Different combinations were used throughout the past four months depending upon her needs and goals.

TREATMENT RESULTS

Gait assessment was repeated after Francheska had been wearing her TheraTogs for approximately six weeks (**Fig. 11 & Fig. 12**). Visual and footprint analysis were repeated. On visual assessment, Francheska showed greater upright trunk alignment and a markedly decreased lateral flexion lurching of her trunk. There was a greater ability to laterally weight shift from the lower trunk and lower extremities and better foot clearance in swing. Gait speed increased at a self-selected speed, based on visual assessment and from the child's feedback. There was greater knee extension prior to initial contact for stance, and the degree of tibial progression decreased (decreased knee flexion) in midstance.

Footprint analysis showed a positive foot progression angle (minimal out-toeing), and a quarter-inch decrease in her BOS. Step length decreased on the right, possibly because the TheraTogs limited the degree of pelvic rotation toward the left. Initial foot contact was on the medial and mid-heel, possibly due to better lower extremity alignment during initial contact in stance phase.

With an understanding of the principles of applied kinesiology and biomechanics, the current dynamic and motor learning theories, and the concepts of manual facilitation techniques inherent in NDT, therapists will find the TheraTogs orthotic and strapping system offers a live-in, dynamic, and enhancing postural and neuro-motor training modality. It also allows the clinician to treat with "hands off" during guided practice by providing "additional hands" that supplement the TheraTogs system during a treatment session and send the "therapist's hands" home for treatment carryover. A therapist can change the strapping selections as goals and needs change. TheraTogs are a problem solving modality linked to a problem solving approach. ■

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