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Case Report

The Effect of Elastic De-Rotation Straps on Functional Ambulation in Cerebral Palsy: A Clinical Case Report

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Abstract

Cerebral palsy is a non-progressive neurologic disorder. One type, spastic diplegia, is characterized by spasticity in both lower extremities to a greater extent than upper extremities are involved. Over the lifespan of a person with cerebral palsy, walking and mobility becomes more impaired, and may be related to the extent to which children and young adults walk. It is therefore imperative that impairments that lead to immobility be addressed. The use of externally applied elastic straps to counteract typical lower extremity postures during gait may be a useful tool for physical therapists to implement with the goal of reducing internal rotation of the hips that is common in spastic diplegia. This case study presents the use of this treatment method in a school-based physical therapy setting. The participant wore the straps daily for 8 weeks. Findings include immediate improvement of lower extremity alignment upon wearing the straps to improve external rotation while upright. Within 30 minutes of removing the straps, her gait pattern returned to baseline, with no carry over effect noted. This information was helpful in determining the utility of treating lower extremity alignment in a child with spastic diplegia. Future studies to determine the efficacy in children with this and other types of cerebral palsy would help to determine the value in a larger population.

Keywords: *Physical therapy; Cerebral Palsy; Dynamic Orthoses; Gross Motor Function Classification System*

Abbreviations

CP: Cerebral Palsy; CDC: Center for Disease Control; US: United States; GMFCS: Gross Motor Function Classification System; PT: Physical Therapy; AFO: Ankle Foot Orthosis; VGO: Visual Gait Observation

Introduction

Cerebral Palsy (CP), a group of non-progressive and irreversible disorders caused by an insult to the developing central nervous system, results in a variety of activity limitations and participation restrictions across the lifespan [1,2]. Blair conducted a summary of the literature and suggests three common characteristics in CP including disordered movement/posture, non-progressive brain abnormality, and early acquisition [3]. The incidence of CP is 2.6-2.9 per 1000 live births [4] and the clinical presentation is varied.

Classification of CP has long been described by topographical distribution of limb involvement (quadriplegia, hemiplegia, diplegia), and muscle tone (spastic, dyskinetic). The Center for Disease Control (CDC) in the United States (US) estimates that 80% of children with CP have spasticity distributed in a variety of patterns [4]. Kim., *et al.* [5] found a causal relationship between spasticity and muscle strength, which in turn had an effect on gross motor function. A direct link between muscle strength and gait in children with CP has also been established [6]. An example of this relationship as it relates to function in CP is the increased energy expense during gait. Lower

extremity positioning during gait may contribute to an inefficient gait pattern, and includes equinovarus, excessive internal rotation of the hip(s), scissor gait (hip adduction), crouched gait, or toe drag during swing phase of gait [7]. The energy cost of maintaining upright positioning to overcome these postural impairments is high [8].

A modern, function-based classification system was reported by Palisano., *et al*. [9] and is known as the Gross Motor Function Classification System (GMFCS). In this system, lower classification levels are associated with fewer motor impairments and greater independent mobility. Higher GMFCS levels indicate a dependence on wheeled mobility for locomotion.

Activity limitations are subject to change throughout the lifespan of a person with CP. Research indicates that a significant proportion of adults with CP experience a decline in walking as they age, with the greatest predictor of decline being the level of walking prior to and during early adulthood [10]. These factors would suggest that a major goal in pediatric physical therapy must be related to preventing or delaying the onset of secondary impairments to preserve functional ambulation and mobility after this skill has been acquired.

Physical therapy (PT) has been a critical component of the rehabilitation management of CP for decades [11]. A major focus of PT in this population is to improve the development of normal postural reactions for support and control of movements, including gait when appropriate. Specific techniques that have been found to be effective in the treatment of individuals with CP are described in the literature review published in 2010 by Martin., *et al*. [12]. Effective strategies include muscle strengthening of key lower extremity muscle groups, functional training to improve gait temporal-spatial measures, endurance training, Body Weight-Supported Treadmill Training, and neurodevelopmental technique [12]. In addition to PT, orthotic intervention, has also been widely used to correct lower extremity alignment, with improved energy efficiency during gait in children with CP noted [13].

The use of elastic straps in conjunction with traditional ankle-foot orthoses (AFO) use may be helpful to provide dynamic assistance to key muscles that are weak. There is minimal evidence investigating the efficacy of this technique. The indications for use of elastics to achieve dynamic lower extremity bracing in a child with CP has been outlined in one case report [14]. In this report, the participant was a 4-year-old girl who was diagnosed with CP and spastic diplegia. Spastic diplegia is characterized by spasticity primarily in lower extremity muscles and less involvement of upper extremities [2]. The participant of this study was treated using elastic straps to assist with hip external rotation. Before treatment, her posture was remarkable for bilateral knee flexion, hip flexion with internal rotation, and ankle equinus. Functional improvement in her ability to engage in independent stance activity (transfers and gait) previously not achieved was reported after 1 week using elastic straps. Regression reportedly occurred after "several days" without the intervention [14].

More recently, the use of customized external strap orthoses in 9 children with "mild CP" was investigated [15]. A similar strapping system was used, but the children in this study were examined in bare feet, with and without elastic straps. The results of this study suggest improved loading pressure across the foot and greater lateral rotation of the hips during gait [15]. One problem with this study is that the use of straps without footwear is not a realistic option in community settings.

The purpose of this case study was primarily to assess the effects of elastic orthoses applied in conjunction with AFO use to facilitate external rotation of the hips on lower extremity posture during gait. A secondary aim was to analyze the potential for any functional improvement to endure over time.

Materials and Methods

Participant

The participant in this case study was a 6-year, 4-month-old female elementary student with a diagnosis of CP, spastic diplegia. She was categorized at GMFCS Level III, indicating an ability to walk using a walker in most indoor settings, but requiring a wheelchair for longer distances or outdoors. Her medical history indicated that she was a fraternal twin born at 28 weeks' gestation, after pregnancy complicated by cervical cerclage. All gross motor milestones were delayed and she underwent hamstring lengthening surgery at 4 years to

correct muscle imbalances caused by spasticity. At the time of this case study, the participant was taking 5mg of oral baclofen twice daily to help reduce spasticity. A side effect of this medication is muscle weakness. She wore bilateral hinged AFO's for support and alignment of her ankle joints, and received ongoing physical, occupational and speech therapy services since infancy. Prior to this study, she had not used the intervention of external elastic straps as a means to minimize internal hip rotation and toe drag during gait.

Intervention

This participant was considered to be an excellent candidate for the use of external elastic straps. She was able to independently ambulate using a posterior walker, exhibiting moderate scissoring and toe drag during swing phase of gait. She was cognitively able to participate in a progressive rehabilitation program in her self-contained school setting.

The external elastic strap was applied by her individual classroom aide, who was trained by the treating PT. Her shoes were fitted with an elastic strap fixed to the distal end of her shoelaces. The strap was wrapped in a lateral direction around her lower leg continuously with a line of pull that promoted lateral rotation 2 times (once below the knee, the other above the knee) and affixed to a mesh pelvic band with clips positioned posteriorly, near her anterior superior iliac spines bilaterally. This device was worn daily for a gradually increasing amount of time over 8 weeks. The final 2 weeks was a total of 240 consecutive minutes each day. A period of time longer than 8 weeks was considered, but found to be not feasible due to scheduling challenges in a school-based setting. The wear schedule is included in Table 1; participant with and without strap use is depicted in Figures 1 and 2.

Week Number	Time in Minutes
1	30-60
2	60-90
3	120
4	120
5	180
6	180
7	240
8	240
Total	**1170-1230**

Table 1: *Wear Schedule: Time wearing external elastic straps during school hours.*

Assessment Method

The outcome measure used in this study was based on the parameters observed in the case study by Nuzzo [14]. Gait was observed for the presence (graded 1) or absence (graded 0) of hip flexion during swing phase while the participant walked toward the camera; heel strike, foot flat, toe off and hip neutral position during stance phase was observed when walking away from the camera.

Examination of the participant's gait by the pediatric physical therapist included video-taped visual gait observation (VGO). This method was selected because it was the only tool available in this school-based setting. It is relatively inexpensive and requires video equipment that is readily available in the audiovisual department of most public schools. The use of video recording has been used in the literature to evaluate observational gait methods [16,17].

Figure 1: *Demonstrates strap application and alignment while wearing straps.*

Figure 2: *Demonstrates alignment while taking a stride without wearing straps.*

VGO was performed at the beginning of week 1 and at the end of weeks 4, 6 and 8. On each video data collection day, the participant completed 6 total passes using her posterior walker along a 20-foot path: 2 passes with video recording while the child walked toward the camera and away from the camera for each of 3 conditions, including pre-application of straps, after application of straps and 30 minutes after straps were removed later in the day. Analysis of the video was completed by the treating therapist.

Results and Discussion

The results of this intervention included consistent demonstration of isolated hip flexion during the swing phase of gait under all conditions. Heel strike was not evident during any of the conditions. The participant demonstrated foot flat, toe-off and neutral hip position (no internal rotation) only when wearing the external elastic strap orthoses, with no carry over effect observed 30 minutes after the straps were removed. The effect of the gait change was immediate after applying the straps, and the duration of wearing them did not have an effect on either alignment or carry over. Gait components for the three conditions are provided in Table 2.

GAIT		Condition											
Phase	Component	Initial-No Straps				Wearing Straps				Straps Removed			
		W1	W4	W6	W8	W1	W4	W6	W8	W1	W4	W6	W8
Swing Phase	Hip Flexion	1	1	1	1	1	1	1	1	1	1	1	1
Stance Phase	Heel Strike	0	0	0	0	0	0	0	0	0	0	0	0
	Foot Flat	0	0	0	0	1	1	1	1	0	0	0	0
	Toe Off	0	0	0	0	1	1	1	1	0	0	0	0
	Hip Neutral Rotation	0	0	0	0	1	1	1	1	0	0	0	0
Total		1	1	1	1	4	4	4	4	1	1	1	1

Table 2: *Gait Analysis.*

A score of 0=component not seen, 1=component seen. The higher total for each week while wearing the elastic straps indicates the presents of the desired lower extremity posture under that condition. The improvement did not last after the straps were removed. W = Week

This case study outlines one method to improve alignment and efficiency during gait in a young child with CP, classified at GMFCS Level III with spastic diplegia. The protocol utilized was modified from the Nuzzo study in that the straps were affixed to the distal part of the shoe rather than to the child's orthotic device [14]. This is a design choice that offers less permanence, therefore, more options for not wearing the straps if desired. The methods used in the current study were more indicative of modern use of elastic straps in therapy. Outcomes of VGO were similar except there was brief carry over of the treatment effect following removal of straps observed in the Nuzzo case [14] and none in the current one.

The current study also differs from the study conducted in 2015 by Chang., *et al*. In the Chang study, participants were bare foot during baseline data collection, and also when elastic straps were applied. The direction of the strap application toward external rotation was similar, however. Although Chang et al. had more participants, the application of straps without shoes is not acceptable in a school setting [15].

Conclusion

Atypical alignment of the lower extremities during gait is a common finding in children who are diagnosed with CP [7]. People with spastic diplegia may remain ambulatory throughout their lives; however, research suggests a decline in mobility in adults with CP [10]. Prior walking, age, continuation of weight bearing activities all appear to be a strong predictor of continued ambulation according Morgan *et al*. [10]. This study also suggests that the decline of mobility in aging people with CP is due to multifactorial reasons, including environ-

mental context, distance walked, and a change in the GMFCS level (from III to IV). The causal relationship between spasticity, strength, and gross motor function in children with CP provides background information for the therapist who is interested in finding methods to counter act the effects of spasticity in children and adults with CP [5].

The use of external elastic straps applied to counter internal rotation posture commonly seen in children diagnosed with CP and spastic diplegia was an easy and relatively inexpensive way to promote more optimal lower extremity alignment while performing upright activities in this case. Improved alignment may prevent unwanted secondary impairments as the child experiences growth spurts. Given that physiologic changes over the lifespan impact continued gait in people with CP [10], this treatment intervention may be beneficial in the long run. The lack of carry over after elastic straps were removed suggest a need to wear the elastic orthosis full-time to improve hip alignment during dynamic activities. The comfort of the device would have to be established for lengthy use over time, although there were not any signs of discomfort in this patient. It is expected that the straps would become over-stretched with prolonged use, requiring periodic replacement. Also, as the child develops, her need for support may fluctuate. Close monitoring is recommended to establish the efficacy of continued use. Further studies with a greater number of participants and a control group are warranted to know the long term benefits of elastic strap use in this manner.

A limitation of this study was the lack of gait efficiency assessment. Further research with more participants and a control group should examine not only alignment to gain knowledge of lower extremity positioning, but also the energy expense of gait while wearing this dynamic orthosis versus not wearing them. Additionally, a blinded reviewer would address potential bias toward the target intervention. While it appeared that the effect of the strap use was not carried over once removed, a longer intervention phase would be needed to determine if this was only because the last posttest was performed 8 weeks after initiating the intervention. Replicating this study in an outpatient setting may alleviate the scheduling constraints in a school-based setting.

Finally, motivation and factors affecting performance must also be mentioned as a potential limitation. Children may be differently motivated when they know they are being video recorded. While the timing of the last dose of oral Baclofen did not appear to interfere with her alertness and ability to participate, this could have affected her performance as well, and is therefore worth mentioning.

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Conflict of Interest

No conflicts of interest.

Bibliography

1. Richards CL and F Malouin. "Cerebral Palsy: Definition, Assessment and Rehabilitation". *Handbook of Clinical Neurology* 111 (2013): 183-195.

2. Rosenbaum P., *et al.* "A Report: The Definition and Classification of Cerebral Palsy". *Developmental Medicine and Child Neurology Supplement* 109 (2006): 8-14.

3. Blair E and L Watson. "Epidemiology of Cerebral Palsy". *Seminars in Fetal and Neonatal Medicine* 11.2 (2006): 117-125.

4. Facts | Cerebral Palsy | NCBDDD | CDC.

5. Kim WH and EY Park. "Causal Relation between Spasticity, Strength, Gross Motor Function, and Functional Outcome in Children with Cerebral Palsy: A Path Analysis". *Developmental Medicine and Child Neurology* 53 (2011): 68-73.

6. Ross SA and JR Engsberg. "Relationships Between Spasticity, Strength, Gait, and the GMFM-66 in Persons with Spastic Diplegia Cerebral Palsy". *Archives of Physical Medicine & Rehabilitation* 88 (2007): 1114-1120.

7. Fish DJ. "Characteristic Gait Patterns in Neuromuscular Pathologies". *Journal of Prosthetics and Orthotics* 9.4 (1997): 163-167.

8. Balaban B., *et al.* "The Effect of Hinged Ankle-Foot Orthosis on Gait and Energy Expenditure in Spastic Hemiplegic Cerebral Palsy". *Disability and Rehabilitation* 29.2 (2007): 139-144.

9. Palisano R., *et al.* "Development and Reliability of a System to Classify Gross Motor Function in Children with Cerebral Palsy". *Developmental Medicine and Child Neurology* 39.4 (1997): 214-223.

10. Morgan P and J McGinley. "Gait Function and Decline in Adults with Cerebral Palsy: A Systematic Review." *Disability and Rehabilitation* 36:1 (2014): 1-9.

11. Damiano DL. "Activity, Activity, Activity: Rethinking Our Physical Therapy Approach to Physical Therapy". *Physical Therapy* 86:11 (2006): 1434-1440.

12. Martin L., *et al.* "A Systematic Review of Common Physiotherapy Interventions in School-Aged Children with Cerebral Palsy". *Physical and Occupational Therapy in Pediatrics* 30.4 (2010): 294-312.

13. Brehm MA., *et al.* "Effect of Ankle-Foot Orthoses on Walking Efficiency and Gait in Children with Cerebral Palsy". *Journal of Rehabilitation Medicine* 40 (2008): 529-534.

14. Nuzzo Roy M. "Dynamic Bracing: Elastics for Patients with Cerebral Palsy, Muscular Dystrophy and Myelodysplasia." *Clinical Orthopaedics and Related Research* 148 (1980).

15. Chang, W. D., *et al.* "Changes in Plantar Pressure and Gait Parameters in Children with Mild Cerebral Palsy Who Used a Customized External Strap Orthosis: A Crossover Study." *Biomed Research International* (2015): 1.

16. Langer P. "Video Gait Analysis in the Podiatric Sports Medicine Clinic". *Current Topics in Sports Podiatry* (2011): 149-154.

17. Watelain E., *et al.* "Variability of Video-Based Clinical Gait Analysis in Hemiplegia as Performed by Practitioners in Diverse Specialties". *Journal of Rehabilitation Medicine* 37 (2005): 317-324.

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