

“Effects of a lycra and nylon hip support garment on gross motor function and static stance in a toddler with Down Syndrome: A Case Report”

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Background and Purpose. Children with Down syndrome develop gross motor milestones later than their age-appropriate peers in part due to weakness and increased joint laxity. Physical therapists often utilize various supports during treatment in order to facilitate gross motor development. The purpose of this case report is to investigate the effects of a lycra-nylon supportive hip garment on stance time, hip abduction angle, and gross motor function for a non-ambulatory toddler with Down syndrome. **Case**

Description. The subject was a 20 month old male diagnosed with Down syndrome at birth. He was able to roll and belly crawl at the onset of the intervention, but could not yet pull himself to stand. He was able to stand when placed with a solid surface to support his abdomen, but could not yet stand independently when placed without support. Hip Helpers® support shorts were utilized for thirty minutes once a week for four weeks during physical therapy sessions. They were also used in supervised play during two sessions a day in the home setting for fifteen minutes each. **Outcomes.** A small, but measurable gain was made in the GMFM. Hip abduction angles in standing were narrowed with application of support shorts. Wearing Hip Helpers® support shorts was correlated with longer supported stance times. Throughout the four weeks of treatment while wearing the supportive garment, less external support was needed.

Discussion. In conclusion, Hip Helpers® support shorts may be a helpful adjunct to physical therapy sessions for children with Down syndrome. More research is indicated to establish clinical practice guidelines for appropriate usage for this population.

Introduction

According to the Centers for Disease Control and Prevention, Down syndrome is the most common chromosomal disorder with a rapidly increasing incidence. As of 2020, 1 in every 700 newborns received the diagnosis.¹ Children with Down Syndrome are delayed in gross motor skill development tasks, such as standing, in part related to hyper-flexibility and hypotonia.^{2,3,4} Research by Winders, Wolter-Warmerdam, and Hickey⁵ has created an adapted gross motor skill development timeline for children with Down syndrome. Following a typical progression of gross motor development, they have noted that on average, children with Down syndrome pull to stand from sitting at 16.9 months and begin to cruise at a surface at 18.4 months. Both gross motor skills infer that the child is able to accept weight bearing on his or her feet with a reasonable amount of hip abduction. Therefore, it is necessary for a child to develop these skills prior to others.

Malak et al.⁶ notes that only ten percent of children with Down syndrome in their study achieved independent standing by three years of age, however, by six years, ninety-five percent of children were able to attain this skill. In contrast, typically developing children learn to walk generally around twelve months of age. The authors recognized that delayed walking also affects the cognitive and social domains in addition to delayed a child's independence.⁶ In recent years, heavy focus has been placed on early intervention for children with a special focus on the first three years of life. Harvard University's Center on the Developing Child supports early intervention for children with neurological deficits given that neuroplasticity of the brain decreases with age.⁷ This author believes that standing activities should be added into a physical therapy plan of

care as soon as it is appropriate to do so in a safe manner, as close as possible to the age that typically developing children would do so.

This creates a challenge in part as research by Angelopoulou et al.⁸ has demonstrated that persons with Down Syndrome have greater hip range of motion than typical peers with the largest measured difference for hip abduction. They suggest this is due to pelvic malformations as well as hip adductor low tone. Increased joint flexibility combined with low muscle tone creates significant challenges for children as they learn to tolerate standing. Another concern when it comes to delayed standing is that it is not uncommon for people with Down syndrome to experience concerns with hip dislocation and dysplasia in addition to delayed gross motor milestones.^{1,9} Schoenecker⁹ presents that the reasons behind a higher hip dislocation incidence include low tone, ligamentous laxity, and capsular insufficiency. Additionally, he reasons that it is likely that maladaptive hip biomechanics during development exacerbate these problems.

The Guide to Physical Therapist Practice supports balance, strength, and endurance training as part of a treatment plan for someone with Down syndrome with a use of orthotic devices as necessary under the preferred practice pattern for a person with impaired muscle performance.¹⁰ This author suggests that one way in which all three of these components can be addressed is through supported standing at a surface. Standing at a surface is a precursor to cruising along a surface, standing independently, and independent gait as listed on the Gross Motor Function Measure.¹¹ Stuber¹² discusses standing considerations for children with developmental disabilities. The author agrees that use of adaptive equipment and orthotics is commonly approved to

supplement standing. As a general age guideline, standing programs should be introduced after twelve months of age if appropriate support is provided.¹²

Common interventions to promote improved standing for children with Down syndrome include use of “hard” bracing such as Ankle Foot Orthoses (AFO) and Supramalleolar Orthoses (SMO), to newer “soft orthotic” management (for example, SPIO[®] garments), and taping. Newer lycra “soft orthotic” garments appear to be helpful for core weakness, however, the evidence is limited.¹³ Additionally, this author found no research on the efficacy of lycra garments on assisting with lower extremity deficits, particularly for children with Down syndrome.

Hip Helpers[®] are newly developed lycra and nylon shorts sewn together between the legs to limit hip abduction for children with mobility challenges and have shown promising subjective reports of success with gross motor skill attainment.¹⁴ They are cheap in cost and easily donned and doffed. Generally, in this author’s experience, they are very well tolerated by children overall, much more so than hard braces or compression vests. Although there are considerable anecdotal reports of both parents and therapists appreciating use of such items, there remains the problem of ascertaining whether or not any real progress has been made in gross motor development aided by Hip Helpers[®]. The purpose of this case report is to investigate the effects of a lycra-nylon supportive hip garment on stance time, hip abduction angle, and gross motor function for a non-ambulatory toddler with Down syndrome.

Case Description

The subject of this case report was a 20-month-old male referred by his pediatrician to outpatient physical therapy due to a diagnosis of Down syndrome and resultant developmental delay. He was born in a rural hospital at 38 weeks gestation and transferred immediately to a tertiary care hospital. He was admitted to the neonatal intensive care unit (NICU) for one month due to concern for congenital heart disease and respiratory distress. At one month of age, he was discharged home with early intervention PT, OT, and SLP services. He continued to receive early intervention services and has received outpatient PT, OT, and SLP services weekly after his first birthday.

By 20 months of age, he was able to roll from supine to prone and prone to supine. He was able to prop with decreased elbow extension, pivot, and belly crawl in prone. Although he typically sat with over-abduction and external rotation of his hips to do so, he was able to sit independently with hands free for play. He demonstrated emerging skills with tall kneeling once placed but did not yet transition himself to tall kneeling nor to standing. When placed in standing, he presented with a tendency to support himself at his lower abdomen via leaning into a surface. He also demonstrated forward flexion of the spine with relation to his hips. He over-abducts his legs in standing as well and had poor balance reactions. Within the past 3 months he had learned to accept weight on his feet in standing. He has had bilateral supramalleolar orthotics for four months prior to this case report. They were consistently used throughout therapy and in the home setting. As he is delayed in his ability to stand without support and to ambulate, his mother had decided to order Hip Helpers® support shorts to use with him at home. His parents wish for their son to be as independent as possible and for him to learn to

meet his motor milestones to the best of his ability. They also wish for him to be able to cruise along a surface with support within the next eight months.

Prior to intervention with Hip Helpers[®] support shorts, the child was assessed via the Gross Motor Function Measure (GMFM)-88 item test.¹⁵ The GMFM was originally developed to assess gross motor development in children with cerebral palsy but has been found to be reliable and valid for children with Down syndrome as well by Russell et al.¹⁶ The authors compared the GMFM to the motor assessment of the Bailey Scales of Infant Development, second edition, and found the GMFM to be more responsive to demonstrating change, particularly when “reported” scores are used. For this method, test administrators may score the test based on parental report of what a child can accomplish in addition to what is observed in the clinic. The GMFM consists of five dimensions, which are labeled: A (lying and rolling), B (sitting), C (crawling and kneeling), D (standing), and E (walking, running, and jumping).^{15,17} Scores range from zero to three. A score of zero indicates the child did not initiate the movement. A score of one describes initiation of movement at a level of ten percent or less. A score of two indicates ten to ninety-nine percent completion of the task. To earn a score of three, the child must complete the task. The option of “NT”, not tested, is also given. This test is appropriate from five months to sixteen years of age and to encourage a child to complete the task, verbal encouragement and physical demonstration may be given.^{15,17,18} Of note, the GMFM is offered in a 66 and 88 item version. The 88 item version was utilized with the subject of this case report as it is recommended over the 66 item test for children wearing shoes and orthotics as well as those with a higher level of motor disability.¹⁸

Table 1 lists the child's score on the GMFM. Dimensions C and D were identified as goal areas by his mother and therapist with a goal total score of 3.57%. He was wearing bilateral supramalleolar orthotics and shoes during this assessment and his mother was present to confirm his ability to perform items was accurate to his home performance. This test was administered prior to the child's consistent daily use of the support shorts both at home and in the clinic.

Using the schedule of gross motor development developed by Winders, Wolter-Warmerham, and Hickey⁵, this writer was able to assess where the child's gross motor skills were relative to other children with Down syndrome. The average age for a child with Down syndrome to belly crawl five feet was found to be 14.2 months in their study, with the next milestone being pull to stand from sitting, which occurred at 16.9 months on average. Using these calculations, it was determined that the child in this study lies between the 75th to 95th percentile compared to other children his age with Down syndrome as he is not yet pulling to stand from sitting but sits independently.

Three weeks after administration of the GMFM-88, initial measurements of stance time and hip abduction angles were taken. There was a delay between initial administration of the GMFM-88 and these measurements due to the child's illness.

To determine stance time, the child was lifted into the air and then placed next to a firm foam supportive surface 53 centimeters tall. Care was taken that his feet were one step length or less from the surface in order to promote stability without significant amounts of trunk flexion or extension. If he did not remain in standing greater than 5 seconds, the trial was not counted. Three trials of stance time were completed both while wearing Hip

Helpers® support shorts and without in order to average the times for greater reliability. As there was not found to be a gold standard method of timing stance in the literature, the author followed a procedure as close as possible set forth by Aranha et al.¹⁹ In their study, timing of stance began the moment one foot was raised and ended at loss of balance as indicated in part by movement of the weight-bearing foot from original positioning. As the child in this case report could not stand independently, timing of stance was modified to begin the moment his feet touched the floor and ended if he moved either leg as both were full weight bearing or if he removed both hands from the surface and began to fall. He was able to stand an average of 36 seconds without Hip Helpers® support shorts and an average of 58 seconds while wearing them.

Hip abduction angles were measured in standing via a relatively new method created by Douglas Nunn, PT, DPT of Cincinnati Children's Hospital.²⁰ In order to calculate hip abduction angles in standing, he suggests that it is appropriate to measure the child's inseam as well as the distance between a child's feet. From this point, the following mathematical function is used to determine the hip abduction angle: $\sin\theta = \frac{\textit{opposite}}{\textit{hypotenuse}}$, where the hypotenuse is the child's inseam and the "opposite" is half of the distance between the child's feet. This option was used versus a goniometer in order to be able to very quickly assess the angle in the instance the child could not hold the standing position for a long period of time. Given that this method of measuring hip abduction in standing was developed so recently, no validity data is available. However, Paleg et al²¹ used the same method to successfully measure hip abduction in their study focusing on the effects of weight bearing in standing at different hip abduction angles. As with stance time, in this case report three measurements were taken and averaged with and

without Hip Helpers® support shorts. Without Hip Helpers® support shorts, each initial hip abduction angle was 18.43 degrees and with shorts, 9.12 degrees.

Given this initial information, it was decided that the child would be an excellent candidate to use Hip Helpers® support shorts as an adjunct to therapy and during supervised play sessions at home. He did not have a history of hip dislocation concerns and responded well to wearing the shorts. In fact, he appeared to be steadier in several positions and was willing to reach further outside of his base of support both in sitting and in supported standing, which allowed him greater interaction with his environment.

Intervention

Hip Helpers® support shorts were utilized in physical therapy sessions over a period of four weeks in the clinic with the ultimate goal of improving hip stability for static stance. As the child's mother had purchased Hip Helpers® support shorts on her own, the child was exposed to wearing them at home for three weeks prior to their structured use in therapy. There was no set time he was in them, but rather, his mother introduced them to ensure familiarity as it was unclear if he would tolerate a new texture and firmness to his clothing. When the clinical intervention period began, his mother ensured that the subject was in the shorts for supervised play for thirty minutes daily throughout the entire four week session outside of therapy. One intent was to focus on a parent-driven model of therapy in which instruction would be given and then carried out by the child's parent at home as well. With this in mind, sessions occurred one time per week over a timespan of four weeks for thirty minutes each session.

Originally, it was planned that each therapy treatment would begin with static standing play with use of bilateral supramalleolar orthotics but no Hip Helpers® support shorts. His mother and the physical therapist both encouraged play and reaching while he was supported at the height of his axilla (54 centimeters for this child). Toys were presented to him throughout to keep him engaged through two additional trials. This same activity was then completed three more times all while the child was wearing the support shorts. Measurements of his step width measured midfoot to midfoot (to calculate hip abduction angle) and stance time were taken throughout. This was successful for the first two sessions of therapy, but in the third week, the child had progressed such that he was able to stand with axilla height support for at least ten minutes with no other assistance without wearing Hip Helpers®. In order to promote increased independence with standing, as this is a parental goal, PT modified the remaining two sessions to take away axilla height solid support. This was replaced by the physical therapist providing support to the child's elbow and just distal to his shoulder on his left side. Care was taken not to give him support on his shoulder or torso itself as he was then able to decide when to sit on his own versus via being guided by the therapist. Once standing trials were completed, any remaining time for his physical therapy session focused on transitions sitting to modified quadruped over either hip, pull to stand through half kneeling, weight shifts in supported standing for pre-gait activities, and static standing activities in which the physical therapist would give support at his shoulders and gradually lower this to knee level in order to stress balance reactions in standing.

Outcomes

At the end of four weeks of thirty minute guided sessions with Hip Helpers® support shorts, the subject was again assessed via the GMFM in the same method as he had been tested before, while wearing shoes and supramalleolar orthotics but without the support shorts. Scores are listed in Table 1. He made very small measureable gains in Dimension B (sitting) and Dimension D (standing). Specifically, the child had begun to make attempts to attain sitting from standing in a somewhat controlled manner.

Additionally, he made attempts to pull to stand when sitting on the floor. Neither of these behaviors were noted prior to the onset of the four week long intervention period.

Figure A demonstrates the change in hip abduction angles in standing both with and without Hip Helpers® support shorts. In general, while wearing the supportive shorts, his hip abduction angle was decreased by nearly half compared to without the shorts. This did appear to correlate with longer stance times. Stance time data is listed in Table 2.

Two weeks into recorded data, as the child could remain in standing in either condition for at least ten minutes without external assistance from the therapist, less support was given to the child in standing. In the initial two weeks, the surface he stood against was firm and padded to a height of 53 centimeters (see Figure B). For the remaining two weeks, as the physical therapist provided support only to one upper arm in both conditions with and without support shorts, his stance time greatly decreased. As seen in Table 2, regardless of the level of support given to the child, stance time was longer while wearing the support shorts. Assessment of posture demonstrated that in the support shorts, the child demonstrated a more neutral pelvic alignment versus the anterior pelvic tilt he displays without them.

Both the physical therapist and his mother subjectively reported a greater likelihood for the child to reach for items outside of his base of support while wearing the shorts. He also oftentimes would push himself away from the support seen in Figure B to keep his chest off while wearing Hip Helpers® support shorts versus not. His mother reported that during the testing period he had begun attempting to pull himself up on surfaces, but had not been successful to fully do so.

Discussion

Research by Ruiz-González et al²² lends credibility to the use of physical therapy for development of strength and balance for people with Down syndrome. In the clinic, oftentimes physical therapists will use static standing activities as a means to improve balance. The problem occurs when there is one therapist available and that person is trying to both support the child safely and provide some item of interest to keep the child occupied. More physical support is needed in these situations and supportive garments and wraps may help fill this gap.

While this case report is not conclusive, it helps to show that wearable supports may be a helpful adjunct to regular physical therapy sessions that are both cost effective and easy to apply. Johnson et al²³ found that wearable supports were the most commonly used “unique” intervention utilized for children with Down syndrome. These included Hip Helpers®, abdominal binders, SPIO® garments, and Thera-Togs®, among others. Even so, only ten percent of pediatric physical therapists questioned in this study had used such supports. Research to investigate the effects of the use of such supports would be helpful to physical therapists in order to establish guidelines for when application would

be best. Johnson²³ notes that as there are no clear clinical practice guidelines for physical therapy for children with Down syndrome, establishing current trends is a helpful first step.

This case report was limited by the short length of time the intervention was applied and a change in the level of support given to the child in standing. A period of four weeks certainly impacted the amount of reasonable progression one would expect a child with Down syndrome to display as measured on the GMFM. Additionally the ending score on the GMFM may have been impacted by the amount of time (three weeks) between the initial GMFM scoring and onset of clinic instructed use of Hip Helpers[®]. This case report was performed over the winter months as well, when it is common for the subject of the report to be ill with various upper respiratory illnesses. Strengths involved his family's dedication to consistent use of the support shorts for thirty minutes a day outside of therapy, which they performed with excellent adherence (greater than 90% of the time). This case report was influenced heavily by the support and encouragement given to the subject by his mother. Her experience as a local elementary school teacher and history of working with children with developmental disabilities provided him with increased success at home. There may have been an impact on his performance as the child received occupational therapy as well as additional physical therapy from the state early intervention program.

Certainly, this case brings to light the importance of parent and therapist teamwork in pediatric physical therapy. Although the concept of family centered care first began to be promoted over fifty years ago with the teachings of humanist psychologist Carl Rogers, only more recently has rehabilitation medicine demonstrated a shift to this

paradigm.²⁴ Hip Helpers[®] support shorts were designed in early intervention, which is itself heavily focused on family centered care.^{14,25} The idea for this case report was inspired by the parent of the child involved as she took the initiative to research options to promote improvement of her child's gross motor skills.

The child involved in this case study was restricted in his ability to participate in standing activities that he could perform with age appropriate peers. The good support from his family and therapy team created positive environmental factors that may have encouraged his standing improvements. On a personal level, the child involved displayed excellent motivation to play in standing. These elements assisted him in combating the challenges he experiences with regards to decreased muscle strength and delayed motor milestones due to Down syndrome. There is hope that the positive elements of family and therapy support combined with the ingenuity of new products such as Hip Helpers[®] will assist in decreasing disability for those with Down syndrome in the future.

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Table 1: GMFM Scores

GMFM Dimension	Percentage Score Prior to Intervention	Percentage Score After Intervention
A: Lying and Rolling	100%	100%
B: Sitting	80%	81.67%
C: Crawling and Kneeling	7.14%	7.14%
D: Standing	0%	2.56%
E: Walking, Running, and Jumping	0%	0%

Table 2: Stance Time

Week	Without Hip Helpers® Support Shorts	With Hip Helpers® Support Shorts
1	36 seconds	57.67 seconds
2	40.33 seconds	185 seconds
3	unable > 5 seconds	21.67 seconds
4	unable > 5 seconds	35 seconds

- Please note, the dark line break indicates a change in supportive surface that is referenced in the text.

Figure A: Hip Abduction Angles

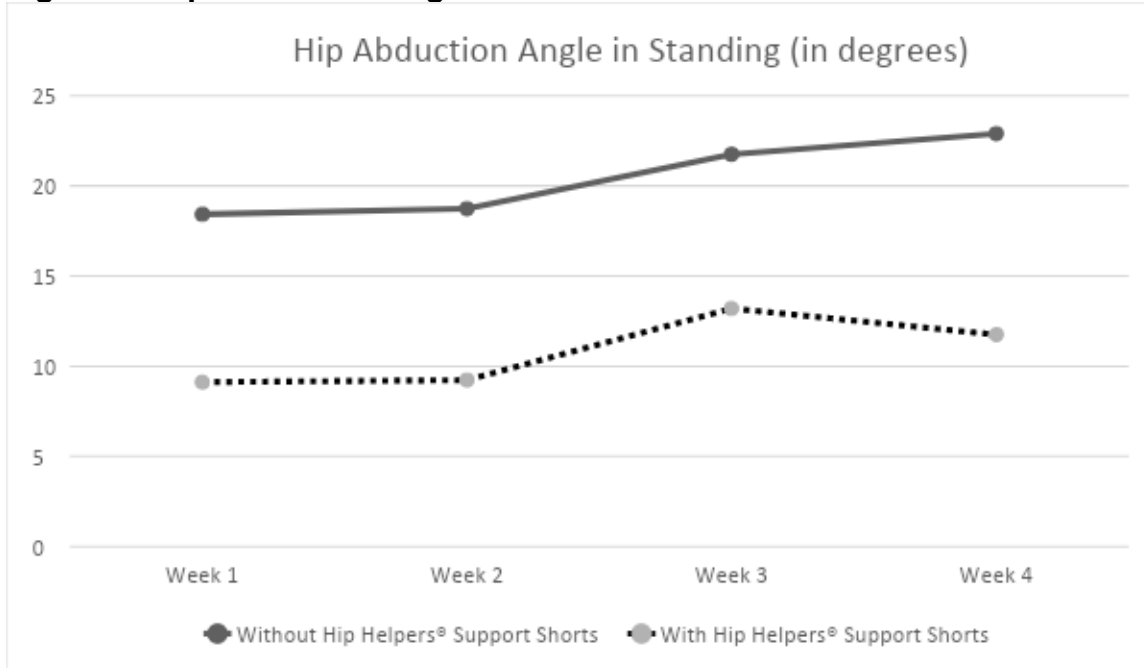


Figure B: Standing Support

