CASE STUDY

EFFECT OF ORTHOTIC SUBTALAR ALIGNMENT WITH CO-ACTIVATION EXERCISE FOR ALTERATION IN GAIT ENDURANCE IN A CHILD WITH CEREBRAL PALSY - SINGLE CASE STUDY

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ABSTRACT

Background: Energy cost of walking is two times higher in children with cerebral palsy when compared with normal children; this may be due to gait abnormalities. There is a negative influence on physical activity and early onsets of fatigue in activities of daily living are evident in cerebral palsy children and the reason for this is increase in energy cost of walking. Therefore, the treatment techniques which targets on correction of gait abnormalities and energy conservation during walking are important to maintain or improve independent functioning. The aim is to find out the effects of using Supra Malleolar Orthosis (SMO) along with co-activation exercise in the increase of gait endurance and also to encourage independent skills and abilities in cerebral palsy child.

Methods: A 14 years child with spastic hemiplegic cerebral palsy was treated with custom made supra malleolar orthotic which was designed with an orthotic support followed with specific exercises, co-activating dorsiflexors and plantar flexors actively and with assistance. The subject was made to do the co-activation exercises 3 days per week for 8 weeks. Step length, stride length, cadence, navicular drop test, medial arch height and calcaneal eversion were measured before starting the treatment and at the end of 8th week.

Results: the results of treatment shows that there is an improvement in 2 minutes’ walk test from 7 (pre-test) to 13, step length from 22 (pre-test) to 32, stride length from 36 (pre-test) to 47, cadence from 39 (pretest) to 37 after the use of Supra Malleolar Orthosis (SMO) and a co-activation exercises intervention. There was a clear and significant improvement noted in navicular drop test, medial arch height and calcaneal eversion after a period of 8 weeks use of orthosis and exercise intervention when compared with pre-test value.

Conclusion: Orthotic subtalar alignment with co-activation exercises for alteration in gait endurance in a child is showing significantly good results in this case study of a child with cerebral palsy. The Co-activation exercise with Supra Malleolar Orthotic support reduces the intensity of symptoms and improved gait parameters in cerebral palsy child.

Keywords: Cerebral Palsy, Supra Malleolar Orthosis, Co-activation exercises, gait.

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Cerebral palsy is due to reduced blood supply for developing brain, which is a group of motor disorders with permanent disability [1]. Symptomatology is too diverse in Cerebral Palsy [2]. The dysfunctions in cerebral palsy vary greatly and the severity also ranges from slight clumsiness to loss of co-ordinated movements which is impossible to treat. Generally, at the developmental stage of six and half to nine months and when the baby is starting to move, in which mobilization process, preferential use of limbs, asymmetry, or gross motor developmental delay can be observed.

The most widespread form of cerebral palsy, is spastic diplegia, which is characterized by motor in-coordination, essentially in the lower end, that impairs many functional abilities, most particularly ambulation which is resulted from brain damage at birth that averts proper development of the pyramidal tract whose meaning is that certain spinal nerve receptors are unable to properly absorb the gamma amino butyric acid which results in improperly regulated tone in the affected areas. People with this disorder (spastic diplegia), have difficulty in their daily schedule where they walk slowly and have difficulty in walking up and down stairs on foot or running. Weakness of the ankle plantar flexors, knee extensors, and hip extensors are the common gait patterns which also have been known by intensive knee and hip flexion. Spasticity in the legs is so rare and not stops ambulation totally; people with spastic diplegia can walk in most of the cases. Regardless, spastic diplegia does result in the signature “scissoring gait”. The person with spastic diplegia cerebral palsy, his gait is typically characterized by a crouched gait.

Majority parents of children with CP has a concern which is the ability to walk, and the primary focus of most therapeutic interventions addressing the motor problems seen in children with spastic diplegia also improving or maintaining this ability is often considered. The stability of knee joint during stance is a challenging task in cerebral palsy children, due to the weakness of quadriceps and loss of knee joint control. They will adopt compensatory stance with hyper flexed knee joint which can be treated with quadriceps strengthening programs.

The joint contractures and muscle weakness may lead to challenging situations to the cerebral palsy child to walk and the amount of energy expenditure to overcome the restraints is also more. So the treatments should concentrate energy expenditure techniques and promotion of independent function. To prevent deformities in cerebral palsy children orthotics have been used from long time. Application of ankle and foot orthosis of various designs has effectively altered the biomechanics of gait in individuals without neurological impairments. The effectiveness of orthosis in quadriplegic cerebral palsy was proved in severals without neurological impairments. The effectiveness of orthosis in quadriplegic cerebral palsy was proved in severals without neurological impairments. The effectiveness of orthosis in quadriplegic cerebral palsy was proved in severals without neurological impairments. The effectiveness of orthosis in quadriplegic cerebral palsy was proved in severals without neurological impairments.
Loss of endurance and muscle weakness is evident in the adolescent cerebral palsy individuals, the reasons to be considered for difficulties in functional upright abilities including ambulation. These individuals also score low on different indices which measure physical fitness due to “deconditioning” of lower limb muscles. This poor musculoskeletal conditioning and possible interventional strategies are of research interest in today’s neuro-rehabilitation. The positive effects on muscle strength, gait characteristics and some functional abilities are evident with isotonic and isokinetic strengthening programs, but decreases in energy expenditure have not paralleled these changes in strength [5].

The need of the study is to find out the effects of using Supra Malleolar Orthosis (SMO) along with co-activation exercise in the increase of gait endurance and also to encourage the functional and independent skill development. The interest of this study is also to know whether Supra Malleolar Orthosis (SMO) can prevent deformity, muscles contracture and improved walking pattern.

CASE DESCRIPTION

A child diagnosed with spastic hemiplegic cerebral palsy had a pronated foot on the right side. He was 14 years old. The Range of motion is restricted in inversion and partially restricted in dorsi-flexion and plantar flexion. The foot was everted when sitting and standing. The chief complaint of the patient is regarding his gait function, it was not progressing and he walks with slow steps which may be due to inadequate balance which was caused by subtalar joint displacement and evertion of foot. The patient can walk without support but with great difficulty as he has presented with spasticity. The child can walk only a few steps independently due to muscle weakness.

| Sl. No | Movements       | Range of motions noted |
|--------|-----------------|-----------------------|
| 1      | Knee flexion    | 0-135° 0-135°         |
| 2      | Ankle dorsi flexion | 0-12° 0-20°      |
| 3      | Plantar flexion | 0-50° 0-50°           |
| 4      | Inversion       | 0-20° 0-30°           |
| 5      | Eversion        | 0-10° 0-15°           |

Table 1: Ranges of motions in both lower limbs

Table 2: Functional examination of both lower limbs

TREATMENT PROCEDURE

The treatment procedure was clearly explained to the parents. The pre-test assessment such as step length, stride length, cadence, and subjective gait assessment for determining subtalar joint position level and navicular drop was measured using navicular drop scale, medial arch height was measured using a caliper and calcaneal eversion was measured using goniometer.

Step length, stride length and cadence are measured during the 2 minutes’ walk test. Navicular height was measured from the floor to the most inferior portion of the navicle, for the baseline outcome. Custom made supra malleolar orthotic was designed with an orthotic support followed with specific exercises, co-activating dorsiflexors and plantar flexors actively and with assistance. The subject was made to do the co-activation exercises 3 days per week for 8 weeks. Post-test was taken at the end of 8th week including step length, stride length, cadence, navicular drop test, medial arch height and calcaneal eversion. Child was asked to sit or stand with foot flat on the floor and therapist will encourage tibia to roll on talus when child was doing sitting to standing from 90-90 position at hips and knees either using shoes or orthotic boots. Patient asked to attempt to wrinkle up the towel or tissue paper under the foot by keeping the heel on the floor and flexing the toes. Encourage the child to stand on a soft ball with the involved foot allowing to push the ball in and down towards gravity, which will activate dorsiflexors and plantar flexors.
Figure 4: Co-activation exercise by using ball

DATA PRESENTATION AND ANALYSIS

| NO | Variables                        | Base line week (pre-test) | 2nd week Post-test 1 | 4th week Post-test 2 | 6th week Post-test 3 | 8th week Post-test 4 |
|----|----------------------------------|--------------------------|----------------------|----------------------|----------------------|----------------------|
| 1  | 2 minutes’ walk test (m)         | 7                        | 8                    | 10                   | 11.5                 | 13                   |
| 2  | Step length (cm)                 | 22                       | 25                   | 27                   | 29                   | 32                   |
| 3  | Stride length (cm)               | 36                       | 39                   | 42                   | 45                   | 47                   |
| 4  | Cadence (no. Of steps/min)       | 39                       | 42                   | 41                   | 38                   | 37                   |

Table 3: Pre and post-test values of 2 minutes’ walk test, step length, stride length and cadence.

| NO | Variables                        | Base Line Week (Without Orthosis) | 2nd Week Post Test 1 | 4th Week Post Test 2 | 6th Week Post Test 2 | 8th Week Post Test 3 |
|----|----------------------------------|-----------------------------------|----------------------|----------------------|----------------------|----------------------|
| 1  | Navicular Drop                   | 2                   | 2.2                 | 2.4                 | 2.5                 | 2.7                 |
| 2  | Medial Arch Height               | 3                   | 3.2                 | 3.4                 | 3.5                 | 3.7                 |
| 3  | Calcaneal Eversion               | 6º                  | 5.8º                | 5.6º                | 5.4º                | 5.3º                |

Table 4: Pre and post-test values of navicular drop test (measured by navicular drop scale), arch height (measured by caliper) and calcaneal eversion (measured by goniometer).

Graph 1: Pre-test and Post-test Values of 2 Minutes-Walk Test

Graph 2: Pre-test and Post-test Values of Step Length

Graph 3: Pre-test and Post-test Values of Stride Length

Graph 4: Pre-test and Post-test Values of Cadence

Graph 5: Pre-test and post-test values of navicular drop test (measured by navicular drop scale), arch height (measured by caliper) and calcaneal eversion (measured by goniometer).
RESULTS

Table 3 shows that there is an improvement in 2 minutes’ walk test from 7 (pre-test) to 13 (post-test), step length from 22 (pre-test) to 32 (post-test), stride length from 36 (pre-test) to 47, (post-test), cadence from 39 (pretest) to 37 (post-test) after the use of Supra Malleolar Orthosis (SMO) and a co-activation exercises intervention. Table 4 shows that there was an improvement in navicular drop test, medial arch height and calcaneal eversion after a period of 8 weeks use of orthosis and exercise intervention when compared with pre-test value.

DISCUSSION

The purpose of the study is to show the effect of orthotic subtalar alignment with co-activation exercises for alteration in gait endurance in a child with cerebral palsy. The SMO is prescribed for patients who have soft, flexible, flat feet and is designed to maintain a vertical or neutral heel while also supporting the three arches of the foot. This can help in improving standing balance and walking.

In recent studies, the researchers found that Supra Malleolar Orthosis (SMO) will improve the subtalar joint position. Judy Carmick (2012) concluded that orthotic device alignment in the subtalar joint neutral position contributes to beneficial outcomes. This study evaluated the effect of orthotics—Supra-Malleolar Orthosis (SMO) and co-activation exercises on endurance through 2 min walk test on a teenager with spastic hemiplegia. The major finding was that the use of Supra-Malleolar Orthosis (SMO) followed with co-activation protocol results in increase in endurance. The case study also revealed that gait parameters include step length, stride length, cadence have also shown improvement from the baseline assessment.

The post-test value of 2 minutes’ walk test has been increased to 13 meters by the end of eight week of intervention period. Butland et al (1982) have concluded that 2 and 6 min walk test were reproducible as a 12 min walk in patients with respiratory disease and walk test has been considered as an outcome measure for testing patients with disability and also in children and adults with cerebral palsy (CP) [7].

The posttest values of step length have been increased to 32 cm by the end of eight week of intervention period. The results were similar with Wiley and Damiano, which revealed that lower extremity muscle training for 6 weeks with 11 spastic diplegia and 5 with hemiplegia, among those children one child who performed ankle dorsiflexors and plantar flexor of children with CP are about 50 and 35% respectively, when compared with that of children with typical development, suggesting that children with cerebral palsy requires co-activation exercise [12].

In our present study 11 steps/ min increment of cadence and about 2 cm increase in right foot step length were noticed after Supra Malleolar Orthosis (SMO) and co-activation exercise resulting remarkable change in performing endurance in 2 min walk test. This result goes in hand with Gestel 2008, Balaban 2007, Westberry 2007, Romkes 2006, Romkes 2002, Thompson 2000, White 2002, Buckon 2001, Hainsworth 1997, and Yokoyama 2005. There is a statistical and clinical improvement noted in many temporal-spatial parameters of gait like velocity, step-length, cadence, stride length, single leg stance, decreased double limb support time, and energy expenditure. The evidence to support the use of orthoses in the improvement of gross motor skills in both function and quality including stair negotiation skills were available in literature [9] (Thomas 2002, Buckon 2001). In hemiplegic cerebral palsy one side muscle will be week since the use of Supra Malleolar Orthosis corrects the deformity and co-activation exercises strengthens the muscle which are weak. Thus it improves the gait parameters which includes step length, stride length, cadence and in spastic hemiplegic cerebral palsy child.

The goal of orthotic interventions is to correct musculoskeletal alignment in the foot and ankle. The orthosis will maintain Joint alignment and limits the range of motion in applied joints. The radiographic imaging proved the immediate impact of orthosis on changes of bony alignment in the foot. Statistical significance found in calcaneal and talus positions. 25-40% of children achieved a “normal” alignment of joint, when wearing an orthosis (Westberry 2007). This supports the use of orthoses in correcting the bony alignment, and it is proven as a part of holistic and functional approach to improve posture and motor skills.

Objective gait analysis has found to be reliable, particularly when Physical therapy has extensive clinical experience [10]. Outcome measures such as ROM, ankle pronation, muscle strength and gait velocity are important to show changes over time to evaluate progress as to whether the orthotics are functioning better than shoes or boots alone [11]. Natural arch occurs when Subtalar Joint (STJ) is in neutral and arch height varies in considerable population. However due to difficulty in measuring subtalar joint neutrality, there is still controversy about the function of Subtalar Joint (STJ) orthosis.

Engsberg et al reported that muscle strength of the ankle dorsiflexors and plantar flexor of children with CP are about 50 and 35% respectively, when compared with that of children with typical development, suggesting that children with cerebral palsy requires co-activation exercise [12]. Dod et al 2013 has demonstrated that minimum of 6 weeks program will improve the ability to generate muscle force in children with cerebral palsy. Cerebral palsy children with some voluntary control and mild equinus are benefit more from an orthosis of less restriction (Romkes 2002 [13], Morris 2002). If dorsiflexors with knee extendors are actively contracting, supramalleolar orthosis of less restrictive style is best to use. It was seen that use of orthotic device and co-activation exercise improves gait and foot abnormalities in spastic hemiplegic cerebral palsy child after 8 weeks period of intervention. So orthotic device and co-activation exercise has a good effect in treating spastic hemiplegic child and also signifies that use of Supra Malleolar Orthosis (SMO) improves the gait pattern in children and is useful in physiotherapy practice.
CONCLUSION
Orthotic subtalar alignment with co-activation exercises for alteration in gait endurance in a child is showing significantly good results in this case study of a cerebral palsy child. The Co-activation exercise with Supra Malleolar Orthotic support reduces the intensity of symptoms and improved gait parameters in cerebral palsy child.

REFERENCE
[1] Kenneth W Lindsy. Neurology and neurosurgery illustrated.5th edition; 2010.
[2] Molnar GE. Rehabilitation in cerebral palsy. West J Med 1991; 154(5): 569–572.
[3] Kasser JF, MacEwen GD. Examination of the cerebral palsy patient with foot and ankle problems. Foot Ankle. 1983;4(3):135-144.
[4] Bjornson KF, Schmale GA, Adamczyk-Foster A, Mc Laughlin J. The effect of dynamic ankle foot orthoses on function in children with cerebral palsy. J Pediatr Orthop. 2006; 26(6):773-776.
[5] Baratta, Solomonow, Zhou, Letson, Chuinard, & D’Ambrosia. Effect of age and speed on coactivation, variability, and joint kinetics during walking. Kinesiology, 1988.
[6] Balaban B, Yasar E. The effect of hinged ankle-foot orthosis on gait and energy expenditure in spastic hemiplegic cerebral palsy. Disabil Rehabil. 2007 Jan 30;29(2):139-44.

[7] Butland, R.J., Pang, J. & Gross, E.R. Two-, Six- and 12-minute Walking Tests in Respiratory Disease. Br Med J (Clin Res Ed). 1982 May 29; 284(6329): 1607–1608.
[8] Wiley ME, Damiano DL. Lower-extremity strength profiles in spastic cerebral palsy. Dev Med Child Neurol. 1998 Feb; 40(2):100-7.
[9] Buckon CE, Thomas SS, Jakobson-Huston S, Sussman M, Aiona M. Comparison of three ankle-foot orthosis configurations for children with spastic hemiplegia. Dev Med Child Neurol. 2001 Jun;43(6):371-8.
[10] Brunnekreef JJ, van Uden CJ, van Moorsel S, Kooloop JG. Reliability of videotaped observational gait analysis in patients with orthopedic impairments. BMC Musculoskelet Disord. 2005; 6:17.
[11] Boggaett BD, Young G. Ankle joint dorsiflexion: establishment of anormal range. J Am Podiatr Med Assoc. 1993; 83:251-254.
[12] Jack R. Engsberg, sandy a. Ross, Kevin W. Hollander, and T.S. Park. Hip spasticity and strength in children with spastic diplegia cerebral palsy. Journal of Applied Biomechanics. 2000;16(3): 221-233
[13] Romkes J, R. Comparison of a dynamic and a hinged ankle-foot orthosis by gait analysis in patients with hemiplegic cerebral palsy. Gait posture. 2002 Feb; 15(1):18-24.

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