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Effect of Articulated Anterior Floor Reaction Orthosis on Gait Efficiency Stride and Characteristic in Diplegic Children with Crouch Gait

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ABSTRACT

Introduction: Cerebral palsy is the most common physical disability in childhood. It is a disorder resulting from sensory and motor impairments due to perinatal brain injury with lifetime consequences that range from poor adaptive and social function to communication and emotional disturbances, Infants with cerebral palsy have fundamental disadvantage in recovering motor function; they do not receive accurate sensory feedback from their movement.

Objective: To study the effect of articulated anterior floor reaction orthosis on energy efficiency and stride characteristics in diplegic children with crouch gait

Purpose: Purposes of this study include;

1. Articulated anterior floor reaction orthosis will result in significant improvement in energy efficiency in diplegic children with crouch gait
2. Articulated anterior floor reaction orthosis will significantly improve the stride characteristics in diplegic children with crouch gait.

Design: Pretest-Post test control group experimental design.

Setting: Indian spinal injuries center, vasnt kunj, New Delhi.

Participants: A sample of convenience of 30 subjects took part in this study. Informed consent was taken from the parents/guardian of the subjects after the subjects were recruited. Subject who fulfilled the inclusion criteria and were ready to participate in the study.

Intervention: The subjects were assisted for gross motor function, modified As worth scale. Following subject were asked to perform walking with the ankle foot orthosis and articulated anterior FRO. The whole procedure was single session, which lasted for approximately 60 minute. The following parameter noted were taken time on 15 meter walkway, cadence, stride length, step length, gait efficiency.

Outcome Measure: Energy Expenditure and Gait Efficiency

Result: The result of this study verifies stride characteristic and gait efficiency improved by articulated anterior floor reaction orthosis. All of the children who participate in the study had consistently and proportionally increase in step length, stride length, walking velocity and reduced energy expenditure.

Conclusion: The improvement of stride characteristic and gait efficiency was clearly seen with the use of articulated anterior floor reaction orthosis in diplegic children with crouch gait. The stride characteristic in the term refers as step length, stride length increased but cadence is not increased significantly. While walking velocity and physiological cost index is significantly improved; so that improvement in gait efficiency. While walking with AFO showed no significant improvement in gait efficiency and stride characteristic

KEYWORDS: *Cerebral palsy, Prenatal, Crouch gait, Gait parameter, Articulated anterior floor reaction orthosis, hinged floor reaction orthosis*

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INTRODUCTION:

Cerebral palsy was first described by the English physician Sir Francis Williams little and was known as little's disease for a long time. Little thought that this condition was caused by neonatal asphyxia later Sigmund Freud, and other scientists challenge little's idea and proposed that a variety of insults during pregnancy could damage the developing

brain. Today it is accepted that only approximately 10% of case of CP can attribute to neonatal asphyxia. Majority occur during the prenatal period, and in most of the cases cannot be identified, the world wide incidence being 2to 2. 5 pre 1000 live birth as much as 70%- 80% of the cases are due to prenatal injuries, with less than 10% cases being due to significant birth of trauma or asphyxia [1]

CP is seen in 10 –18 % of babies in 500-900grams birth weight. Prenatal maternal chorimnionitis is also a significant risk factor accounting for as much as 12 % of cerebral palsy in the term infants and 28% in premature infants. The impairment of voluntary motor control is the hallmark of cerebral palsy. Cerebral Palsy is caused by wide spectrum of development and acquired abnormalities of immature brain. It is the most common physical disability in the childhood. In general term it is described as a group of non-progressive neurological symptoms which cause impaired control of movement and which are evident in the first few years of life usually before age 3. The disorders are induced by damage or faulty development of the motor areas in the brain, disrupting the patient's ability to control movement and posture. Alternation of the central nervous system, which produce the characteristic feature of CP Children such as reduced selective muscles, dependence on pattern movement, abnormal muscles tone, imbalance between muscles agonist and antagonist, across the joint and /or deficient equilibrium reaction, result in gait deviation [2].

Most study show that diplegia is commonest form (30 -40 %) of cerebral palsy. with diplegia the lower extremities are severely involved and the arms are mildly involved, intelligence usually is normal and epilepsy less common. Diplegia is becoming more common as more low –birth-weight babies survive. In these cases there is flexion of the hip, knee and to lesser extent elbows that called crouch gait. [1]

Crouch gait is one of the most prevalent and troublesome movement among the children with diplegic cerebral palsy. Crouch gait is due to abnormally taught and spastic contracture of hamstring are thought to excessive knee flexion in many cases. The crouch gait is commonly treated by surgical length of the hamstring. [3]

Orthotic intervention in ambulatory children with spastic CP is intended to prevent deformity, achieve stable base, and improve dynamic efficiency of gait and achievement of motor skill (condie 1995). Although ankle foot orthosis are frequently used for ambulation of children with spastic CP. These AFO are primarily prescribed for children with spastic hemiplegia to prevent equines deformity. [3] Orthosis can maintain optimum biomechanical alignment of body segment. Lower limb orthosis may improve gait efficiency by restoring the prerequisites through the manipulation of forces acting on the body and reduce energy expenditure further by decreasing the need for compensatory gait deviation to achieve locomotion. The extra energy required using an assistive device and walking device is well known but quantitative studies of extra energy requirement have rarely been done. In spastic diplegia, more energy is required in the initial contact and first rocker cannot take place, because of the excessive vertical excursion of the body's center of mass and additional muscular effort needed to stabilize the hip, knee, energy is wasted instead. Second period of energy wasting may occur during mid stance when GRF passes through the fore foot creating a flexion moment and hence planter flexion- knee extension couple. [4]

The rear entry hinged floor reaction orthosis (articulated anterior floor reaction orthosis) major advantage are that it control second rocker but not interfere with first rocker or third rocker where as the two earlier design essential eliminate the ankle movement in the stance phase. it is more effective than the earlier design and much comfortable. previous study show that the maximum knee extension of knee and ankle dorsi- flexion observed during stance phase in diplegic children. [5]

This study focuses on the effects of using an articulated floor reaction orthosis on the energy efficiency as well as the stride characteristics in diplegic children with crouch gait.

AIM AND OBJECTIVES

To study the effect of articulated anterior floor reaction orthosis on energy efficiency and stride characteristics in diplegic children with crouch gait

HYPOTHESES

1. Articulated anterior floor reaction orthosis will result in significant improvement in energy efficiency in diplegic children with crouch gait
2. Articulated anterior floor reaction orthosis will significantly improve the stride characteristics in diplegic children with crouch gait.

METHODLOGY

This chapter deals with the methods used in this study. These include information on the subjects, and procedures used in data collection, reduction and analysis.

Sample

A sample of convenience of 30 subject took part in this study. these subject were collected from Akshay Prathisthan school, Vasant kunj, Orhtotech appliances, 44/5/2/ East Guru Angad Nagar, Laxmi Nagar, New delhi-92, Indian spinal injuries center, vasnt kunj, New Delhi. Informed consent was taken from the parents/guardian of the subjects after the subjects were recruited. Subject who fulfilled the inclusion criteria and were ready to participate in the study.

Inclusion criteria

1. The ability to come to standing position independently without the use of lower extremity orthosis or assistive device.
2. The ability to walk independently with or without using ankle foot orthosis.
3. Age ranging between 7 – 12 years.
4. Able to understand the commands given.
5. CP children on the level III as defined by Gross motor functional classification system.
6. Spasticity measure on modified Ashworth scale 1and 1+
7. Lengthening of hamstring or TA.

Exclusion criteria

1. Athetoid CP
2. Joint contracture of fixed deformity of hip, knee, ankle.
3. Deep sensory disturbance.
4. Visual loss.

Instrumentation for data collection

1. Paper walk way
2. A Stoop watch
3. Standard measuring tape
4. Marker
5. Oil & shock

Design

Pretest-Post test control group experimental design

PROTOCOL

A sample of convenience of 30 subject of the age group of 7 - 12 years was took part in this study. A detailed explanation of the study given to the subject after that they signed an informed consent form. Following this, the subject was divided into two groups of 15 each. Group 1 consists of control group and group 2 consists of experimental group. Demography data were collected from the subject who inclusion criteria of the study. This includes age, sex, height, and weight. The subjects were assisted for gross motor function, modified Asworth scale. Following subject were asked to perform walking with the ankle foot orthosis and articulated anterior FRO. The whole procedure was single session, which lasted for approximately 60 minute. The following parameter noted were taken time on 15 meter walkway, cadence, stride length, step length, gait efficiency.

Extended Knee with AAFRO

Crouch gait posture-ii

Persisting crouch wearing AFO

PROCEDURE

A signed consent was obtained from the parents/ guardians of every subject. The diagnosis, age, gender and present medical condition were obtained from parents / guardian. A detailed clinical assessment of subject was done. Group 1 consists of ankle foot orthosis user who used AFO more than one year, while group 2 who used Articulated anterior floor reaction ankle foot orthosis. The base line data such as heart rate in the resting condition, heart rate in walking, stride and step length, cadence, walking velocity were collected from subjects from group 1 and group 2 separately. To calculate resting heart rate, the subject rested on a seat and heart rate was monitored for 10 minute to establish the resting rate. Then subject stood up and waited until the heat rate stabilized. On the instruction, the subject walked continuously along the given walk way path at 15 meter. The hart rate at end of each walk was measured and also time taken for each walk was measured. Each subject was given one trial walking before the final assessment to formalize with walking condition. Each subject completed one trial for all of testing condition and asked not to stop and step out side of paper. The walking trial was realized on paper walk way (15 x. 05 meter) in a well light environed, at a self-selected speed.

Oil print method was used in the study in which the subjects were asked to wear socks following which oil is applied to the sole and impression of foot print were taken. These foot print used for comparing the stride characteristic such as stride, step length and cadence. These procedure followed for collection of post intervention data after 21 days of intermittent orthotic wear.

DATA ANALYSIS

Statistical analyses were performed using the SPSS software. A student's t-test was used to analyze difference between the groups. Paired t-test was used to analyze the within group effects. Data were managed on Excel spreadsheet.

RESULT

This chapter deals with results of data analysis for effect of articulated anterior floor reaction orthosis on gait efficiency and stride characteristic in dialogic children with crouch gait.

Comparison of energy efficiency and stride characteristic with AFO and AAFRO. Paired T – test was used to compare the gait efficiency & stride characteristic with AFO and AAFRO.

Table 1 Demographic Data – Comparison between Group 1 and Group 2

Variable	Group 1 (AFO) (n = 15)	Group 2 (AAFRO) (n = 15)
	Mean + SD	Mean + SD
Age	9.7333 + 1.792	9.8667 + 1.807
Height	1.3653 +.088	1.3636 +.083
Weight	32.8000 + 3.986	29.8667 + 3.378

Table 2 Comparison between pre and post data for Group-1

Variable	Pre-data N=15		Post-data, N=15		t-value
	Mean	SD	Mean	SD	
Step length	.3027	.033	.3020	.032	.23
Stride length	.5020	.035	.5013	.035	.29
Cadence	15.733	1.580	15.333	1.291	1.87
Walking velocity	11.9009	1.013	12.1006	.890	.78
Physiological cost index	1.6307	.357	1.4910	.363	1.27

Table 3: Comparison between pre and post data for Group 2

Variable	Pre-data N=15		Post-data, N=15		t-value
	Mean	SD	Mean	SD	
Step length	.3067	.027	.3347	.015	3.73**
Stride length	.5013	.044	.5400	.029	3.93**
Cadence	15.5333	1.727	15.3333	.816	.41 NS
Walking velocity	12.1961	1.203	13.3313	.932	4.66**
Physiological cost index	1.4969	.381	1.0927	.315	8.71**

*** Significant** p<. 001

Table 4 Comparison between Pre and post in Group 1 and Group 2

Variable	Pre-data N=15		Post-data, N=15		t-value
	Mean	SD	Mean	SD	
Step length	.3027	.033	.3067	.027	.36NS
Stride length	.5020	.035	.5013	.044	.05 NS
Cadence	15.7333	1.580	15.5333	1.727	.33 NS
Walking velocity	11.9009	1.013	12.1961	1.203	.73 NS
Physiological cost index	1.6307	.357	1.4969	.381	.99 NS

NS- Non Significant

DISCUSSION

In the present study an attempt was made to understand how articulated anterior floor reaction orthosis affect on stride characteristics and gait efficiency in diplegic children with crouch gait. No clinical study has investigated the effectiveness of FRAFO in the CP children with crouch gait. Most studies discussed in the paper are based on solid or hinged ankle foot orthosis. The result of this study verifies stride characteristic and gait efficiency improved by articulated anterior floor reaction orthosis. All of the children who participate in the study had consistently and proportionally increase in step length, stride length, walking velocity and reduced energy expenditure.

As mentioned earlier, one of the studies supported the significant improvement in kinematics gait characteristics in diplegic CP children who wore hinged FRO including a reduction of knee flexion and abnormal ankle dorsiflexion. Few published studies have showed that the stride length increase with floor reaction ankle foot orthosis but the speed and energy cost not showed any significant improvement.

The ankle foot orthosis trial showed no significant improvement in stride variable (step length, stride length, cadence and walking velocity) and physiological cost index. The articulated anterior floor reaction orthosis concept is to minimize orthotic involvement at the first rocker (Heel rocker) and third rocker (Dorsi-flexion) while assisting a knee extension of toes moment at second rocker. This orthosis stabilize the ankle and subtalar joint, allowed first rocker planter flexion and prevent second rocker dorsiflexion so that the tibia cannot progress anteriorly over the top of talus, so that the result to prevent knee flexion in stance.

Clinical Relevance

Crouch gait usually occurs during adolescent growth in diplegic children. In addition the precipitating factors almost always include lever arm dysfunction / or previous weakening of the soleus. Soleus weakening is usually shortening and comes about either by means of TendoAchellis lengthening. Because soleus weakness and LAD both act to diminish internal movement that restrains forward motion of the tibia, the ankle dorsiflexion during second rocker. This allow to GRF to move behind the knee joint so that instead of exerting an extension force, it now exert a flexion in flexion force on knee in other words, the PF/KE couple no longer exists.

The anterior articulated floor reaction orthosis used to restore the PF/KE couple and to keep to the child to in erect posture. If the patient is maintaining the erect posture, the soleus and hamstring will stretch and so will not grow significantly shorter, correct the LAD. So that the patients walk more frequently knee extension with less energy expenditure. It implies the use of AFRO in clinical practice routinely.

Future Research

No Biomechanical studies have checked with the effectiveness of AAFRO during gait in-patient with CP.

CONCLUSION

The improvement of stride characteristic and gait efficiency was clearly seen with the use of articulated anterior floor reaction orthosis in diplegic children with crouch gait. The stride characteristic in the term refers as step length, stride length increased but cadence is not increased significantly. While walking velocity and physiological cost index is significantly improved; so that improvement in gait efficiency. While walking with AFO showed no significant improvement in gait efficiency and stride characteristic.

REFERNCES

[1] N ardine berker, slime yalcine, (2005), the help to guide CP, pediaratic orthopaedic & rehabilition serires pp-1-31

[2] Chitra sankar & Nandini mundkur(2005)symposium on developmental & behavioral disorders-I, Indian Journal Of Pediatrics, Vol. -72

[3] Dine L dimino, luke E Kelly, Christopher L vaughn (1995) : effect of quadriceps femoris muscles strengthing on coruch gait in children with spastic diplegia, physical therapy, vol-75, no -8

[4] Allison s. Arnold, Michale H. Schwartz, scott L delp and velocities of the hamstring in the evaluation and treatment of crouch gait, gait and posture, 23, 273 -81

[5] Catheelin E buckon, MS, research associate, Michale moore CPO, manger, prosthetic and orthotics department, comparison of three AFO (2001)confrigation for children with spastic hemiplegia, developmental medicine and child neurology, 43 ; 371-378

[6] Anderw A. brouno, MD, bakle, Md efficiency of ambulation determined by oxygen compasuption meaasurment

[7] jean stout and steveen coop, energy expenditure in CP, the treatment of gait problem in CP, pp -146164 Gage

[8] Jamesh R gage and Deborah S. quanbenk, otrhortic and mobility aids in CP PP-273- 285

[9] Orthopedic assessment of CP, spastic diplegia, pp-282-302

[10] Orthotic management of CP, journal of prosthetic and orthotic, 2002 pp- 154 – 162

[11] Jamesh R. gage michle Schwarz, pathological gait and lever dysfunction pp. 180 -204 Gage

[12] Neill stuart Thompson, M. D, F. R. C. S (Trand orth), Richard jonathan baker, ph. D & Trevor childs taylor, F. R. C. S (2001)Relevance of the popliteal angle to hamstring length in cerebral palsy crouch gait, Journal of pediatric ortopaedics, 21:383-387

[13] Jhon R. fiskj, terry j. supan, cerebral palsy, pp. 533-541 Atals of orthotic ii edition

[14] Perry J, Gait analysis methodology in normal and CP pp. 120 -125, Perry J

[15] Euger E bleck, MD, standfrd university school of medicine standard california, special assessment and investigator, 1999/2000, clinics in development medicine orthopaedic management pp 65 – 205

[16] Raja, Kavita MSPT, Joseph, Benjamin Mch ortho, Rana vinay MD (2007), Physiological Cast index in cerebral palsy: it role in evaluating the efficiency of

ambulation, Journal of pediatric orthopaedic, vol. (2), p-130-136

[17] Paulo Robert Garcia lucareil, Mario de oliver lima, change in joint kinematics in children with cerebral palsy while walking with or without floor reaction ankle foot orthosis, clinics, 2007, 621(1): 63-8

[18] Methods of gait analysis, gait analysis : an introduction, pp- 154

[19] C. N duffy, M D, F. R. C. S (TR& orhto), H. K. GRAHAM, M. D, F. R. C. S, A. P. cosgrove, m. d, f. r. . c. (ortho), (2ooo), the influence ankle foot orthsis on gait and energy expenditure in spina bifida, journal. pediatric orthp, 20, 3

[20] Diane L. damino, Edward laws, mark F. able (2006), relationship of spasticity to knee angular velocity and motion during gait in cerebral palsy, gait & posture, 23, -1-8.

[21] F. Danion, E. varieaine, M. bonard, J. pailhoius (2003), stride variability in human gait : the effect of stride frequency and stride length, gait & posture, 66-77.

[22] B. W. stansfield, S. J hilman, M. . E hazelwood, A. M lawsan, A. M. mann (2003), normalization of gait data in children, gait & posture, 17, 81-87

[23] Allison s. Arnold, M arcs G pandy, Scott L. delp (2005), muscular contribution of hip and knee extension during the single limb stance phase of normal gait : a frame work for investigating the cause of crouch gait, journal of biomechanics, 38, 2181-2189