29 - GAIT BIOMECHANIC ASPECTS OF A CEREBRAL PALSY PATIENT

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INTRODUCTION

Children's chronic encephalopathy is defined as a pathology linked to different causes and characteristics, mainly due to muscle stiffness. The disease was described the first time in 1843 by Little. In 1862 a relationship was established between this condition and natural birth. Freud, in 1897, suggested the term cerebral palsy (CP), which was later established by Phelps, when referring to a group of kids that demonstrated severe motor disorders due to an injury or damage to the central nervous system (CNS), similar to motor disorders found in the Little Syndrome (DIAMENT, 1996; ILLINGWORTH, 1958; ROBERTSON et al., 1994; ROTTA, 2001).

There are many definitions of CP in the literature, although, for the specialists the most accepted definition is the one conceived in 1964, which is described as a permanent disorder of posture and movement, due to a cerebral damage in the beginning of life (LEITE; PRADO, 2004).

The cause of CP is attributed to a damage in the CNS development, which can occur during pregnancy, birth or in the first two years of life (CANS, 2000), and the external signals of CP are dependent of the magnitude, extension, and location of the injury that provoked the irreversible damage to the brain, brain stem, or spine (KOMAN et al., 2004).

Specialized research shows very heterogeneous data about the occurrence of CP (NELSON e ELLENBERG, 1978; HAGBERG et al., 1984; STANLEY e ENGLISH, 1986). In 1950, Illingworth estimated 600.000 cases in the United States, which summed up 20.000 a year. In developed countries the occurrence varied from 1.5 to 5.9/per 1000 live births (DIAMENT, 1996). Although in Brazil, there are no official numbers about the occurrence of motor, sensory, or mental disorder patients (ROTTA, 2002). According to Edelmuth (1992), there are 17.000 new cases of CP in Brazil every year.

Ferraretto and Souza (1998) affirmed that CP can be classified in two criteria: type of motor dysfunction present or the location of the body damaged. The spastic form is the most frequent, which is responsible for 88% of CP cases (YOUNG, 1994; GONZÁLEZ, SEPÚLVEDA, 2002). Diplegia occurs in 10-30% of the patients, a majority of which were found in premature births. Diplegia affects the lower limbs with frequent evidence of hypertonia of the adductors, which configures the semiologic aspect defined as Litle syndrome (posture with crossing limbs and "scissors gait") (LEITE e PRADO, 2004).

The biomechanics gait analysis represents a useful tool in identifying the aspects of each clinical case of individuals with CP, assisting in controlling the effects of different treatments (medication, surgery and/or rehabilitation), and generating quantitative reliable information (GAGE, 1993).

Therefore, this study aims to describe the kinematic characteristics of the gait of a spastic diplegic cerebral palsy patient and compare them to normal gait patterns found in the literature.

2 MATERIAL AND METHOD

The participant of this study is a spastic diplegic CP patient, selected intentionally, at age of 18, 5 ft 4.5in in height and 127 lbs of body weight.

For data collection, the SPICAtek® Digital Motion Analysis System (DMAS) 5.0 was used. This system uses tridimensional movement reconstruction, composed of 4 digital video cameras DALSA-CCD-CA-D4, with a resolution of 1024x1024 pixels and frequency of 40 frames per second (fps).

The gait kinematic analyses was performed by monitoring the following angular variables: AJ-D and AJ-E (right and left knees angles) - relative angles formed between the segments of the thigh and leg; AQ-D and AQ-E (right and left hip angles) - relative angles formed between the segments of the trunk and thigh; AT-D and AT-E (right and left ankle angles) - relative angles formed between the segments of the foot and leg (tibiotalar articulation). The movement of the foot in the upward direction was defined as dorsiflexion and in the downward direction as plantar flexion.

Gait kinematic data was obtained through digitalization of the points of interest. The points of interest were as follows; right and left ankle - fibula lateral malleolus; right and left shoulder - acromion angles of scapula; right and left hip - femur great trochanter; right and left knee - femur lateral epicondyles; ball of foot - right and left foot's head of second metatarsal bone. These points were marked with reflexive tape on the respective bone processes, representing the joint axis. In order to minimize errors of digitalization, a Least Square Fit digital filter was used, available in the system (DMAS 5.0), automatically operating at a frequency of 3Hz.

Throughout data collection, the patient studied performed successive gait trials, in preferred velocity, dressing only shorts. Images of ten gait cycles where registered (adopting the initial right heel contact as the start point), after five minutes of adjustment in the laboratory environment. Also, anthropometric variables of height (Seca® Stadiometer with resolution of 1mm), and body weight (Filizola® platform scale with resolution of 0.1kg) were measured to control the variables selected for kinematic analysis.

The data is represented through descriptive statistics in terms of mean and standard deviation. In order to compare the patient gait patterns to the normal gait patterns found in the literature, the Paired t test ($p \leq 0,05$) was used.

The requirements of the Ethics Committee for Research with Humans were followed, where the patient, after being informed about the study, signed the Term of informed consent.

3 RESULTS AND DISCUSSION

Observing Figure 1, the subject studied demonstrates a crouch gait pattern, which is characterized by a bilateral deficit with excessive hip and knee flexion, excessive plantar flexion of the ankle and upper pelvic inclination (PERRY, 2005a).

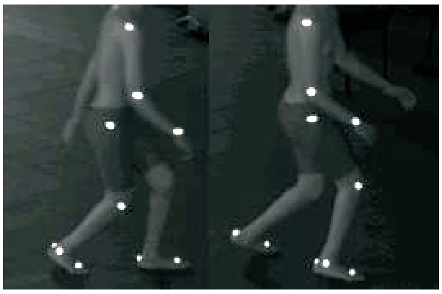

Figure 1 - Characteristic Crouch Gait pattern of patient analyzed.

Figures 2 and 3, represent the angular patterns of right and left hip of the individual analyzed, as well as the angular pattern of the hip articulation as found in the literature (PERRY, 2005b).

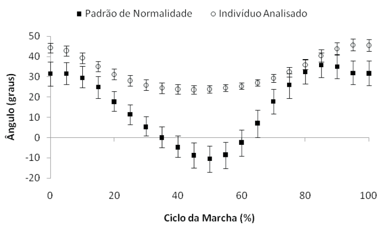

Figure 2 – Patient's left hip articulation. angular behavior during a gait cycle and normal patterns found in the literature.

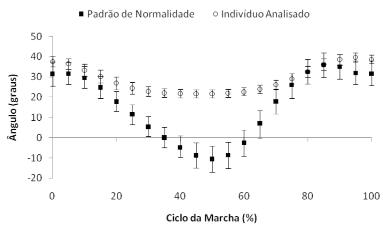

Figure 3 – Patient's right hip articulation angular behavior during a gait cycle and normal patterns found in the literature

The angular behavior of hip articulation (Figure 2 and 3) and the shape of observed curves of the patient analyzed were very close to normal gait patterns (PERRY, 2005b; SUTHERLAND et al., 1998). This was characterized by a simple sinusoidal curve formed by only two motion arches during the gait cycle: extension during the contact and flexion during balance. However, the movement amplitude observed in this articulation ($\approx$20°) was inferior ($p<0.001$) to the normal gait pattern ($\approx$40°) (Figure 3 and 4), due to permanent hip flexion during the entire gait cycle, with absence of the period of hyper-extension which is a characteristic of the end of contact phase (PERRY, 2005b).

Figure 4 and 5, shows the right and left knee angular patterns of the patient analyzed, as well as these normal joint patterns found in the literature (PERRY, 2005b).

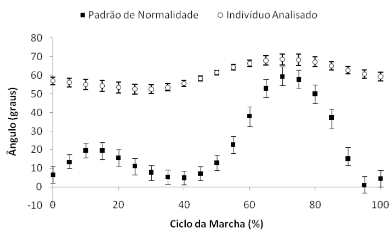

Figure 4 – Patient's left knee articulation angular behavior during a gait cycle and normal patterns found in the literature.

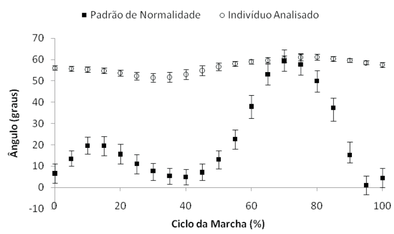

Figure 5 – Patient's right knee articulation angular behavior during a gait cycle and normal patterns found in the literature.

As is observed in Figure 4 and 5, the first flexion wave of the knee, which is characteristic of a normal gait pattern (PERRY, 2005b; SUTHERLAND et al., 1998), is almost imperceptive, in both knee joints of the patient studied. The knee flexion wave, which is essential in absorbing impact caused by initial contact of the foot with the surface, could show a decrease due to the patient already initiating the heel contact with greater knee flexion.

The amplitude of knee flexion/extension of the subject studied during the gait cycle ($\approx$ 15°) (figures 4 and 5) demonstrates a decrease ($p<0,001$) compared to normal patterns ($\approx$60°) (PERRY, 2005b), which is attributed to the crouch gait performed by the subject studied.

Figures 6 and 7, represent the angular behaviors of the right and left ankles of the individual analyzed, as well as the normal patterns of this joint found in the literature (PERRY, 2005b).

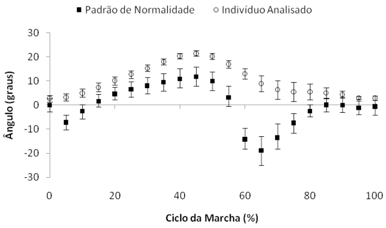

Figure 6 – Patient's left ankle articulation angular behavior during a gait cycle and the normal patterns found in the literature.

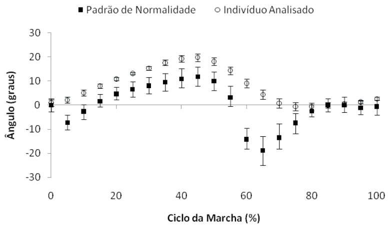

Figure 7 - Patient right ankle articulation angular behavior during a gait cycle and the normal patterns found in the literature.

According to figures 6 and 7, in the angular pattern curves of right and left ankle, the first wave of plantar flexion was not observed, characteristic of normal gait patterns during the load-response mechanism (0-10% of gait cycle) (PERRY, 2005b; SUTHERLAND et al., 1998). This occurs due to the absence or decrease of heel contact when the foot reaches the floor, characterized as flat foot (LEWIS et al., 2000). This is probably the most significant input in justifying the foot dragging pattern during the CP patient's gait.

The angular displacement amplitude of the patient's ankle articulation (right and left) ($\approx$20°), were inferior (p<0,001) to normal patterns ($\approx$30°) (PERRY, 2005b), and may be associated with crouch gait pattern.

4 FINAL CONSIDERATIONS

Considering the results obtained, the patient analyzed demonstrates crouch gait pattern, with a great decrease in movement amplitude of hip, knee and ankle articulation. As well as absence of hip hyper-extension and first wave of knee flexion and ankle plantar flexion during a gait cycle.

Therefore, one believes that the results of this study can contribute to developing rehabilitation programs to help the patient analyzed, focusing on the principal disabilities.

Similar studies are highly recommended to verify if the findings in the present study also apply to other patients.

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GAIT BIOMECHANIC ASPECTS OF A CEREBRAL PALSY PATIENT

Cerebral Palsy (CP) is a permanent disorder of posture and movement, caused by a damage in the development of the Central Nervous System (CSN) in the beginning of life. Therefore, this study aims to describe the kinematic characteristics of the gait of a spastic diplegic CP patient and compare them to normal gait patterns found in the literature. For gait kinematic analyze, a tridimensional Digital Motion Analysis System (DMAS) 5.0 was used, where were measured angular variables of hip, knee and ankle articulations. In order to compare the patient gait patterns to the normal gait patterns found in the literature, the Paired t test ($p \leq 0,05$) was used. Considering the results obtained, the patient analyzed demonstrates crouch gait pattern, with significant decrease in movement amplitude of hip articulation, knee and ankle ($p < 0,001$), also demonstrates absence of hip hyper-extension and absence of first wave of knee flexion and ankle plantar flexion during gait cycle. Therefore, one believes that the results of this study can contribute in developing rehabilitation programs to help the patient analyzed, focusing on the patient's principal disabilities. Another similar studies are highly recommended, in order to verify if the findings in the present study also applies to other patients.

KEY-WORDS: Cerebral Palsy; Human Gait; Biomechanics.

LES ASPECTS DE BIOMECHANIC DE DEMARCHE D'UN MALADE DE INFIRMITÉ MOTRICE CÉRÉBRALE

Le Infirmité motrice cérébrale (IMC) est un désordre permanent de posture et le mouvement, causé par un dommages dans le développement du Système Nerveux Central (CNS) au départ de vie. Donc, cette étude vise à décrire les caractéristiques de cinématique de la démarche d'un malade de PC de diplégique handicapé moteur et les compare à la démarche normale modèle trouvé dans la littérature. Pour la cinématique de démarche analyse, un tridimensional le Mouvement Analyse Système Numérique (DMAS) 5,0 ont été utilisés, où ont été mesurés des variables angulaires de hanche, les articulations de genou et cheville. Pour comparer les modèles patients de démarche aux modèles de démarche normaux ont trouvé dans la littérature, le test de t Mis a été utilisé. In Vu les résultats ont obtenu, le malade analysé démontre le modèle de démarche d'accroupissement, avec la grande diminution dans l'amplitude de mouvement d'articulation de hanche, le genou et la cheville ($p < 0.001$), démontre aussi l'absence de surexcité-extension de hanche et l'absence de première vague de flexion de genou et la cheville flexion plantaire pendant le cycle de démarche. Donc, l'un croit que les résultats de cette étude peuvent contribuer dans les programmes de réhabilitation en voie de développement pour aider le malade analysé, se fixant sur les incapacités du malade principales. Une autre études similaires sont extrêmement recommandées, pour vérifier si les conclusions dans l'étude présente s'appliquent aussi aux autres malades.

MOT-CLÉ: Infirmité Motrice Cérébrale; Démarche Humaine; Biomécanique.

ASPECTOS BIOMECÁNICOS DE LA MARCHA DE UN PORTADOR DE PARÁLISIS CEREBRAL

La parálisis cerebral (PC) es un disturbio permanente y variable del movimiento y de la postura, causado por daños en el desarrollo del Sistema Nervioso Central en el comienzo de la vida. Así, este estudio de caso tiene como objetivo describir las características cinemáticas de la marcha de un individuo portador de PC diplégica espástica y compararlas con el patrón de normalidad disponible en la literatura. Para el análisis cinemático de la marcha ha sido utilizado un sistema de cinemetría 3D (DMAS 5.0), para lo cual han sido medidas variables angulares de las articulaciones de la cadera, rodillas y tobillos. Para comparar los datos de la marcha del individuo analizado con los datos de normalidad disponibles en la literatura ha sido utilizado el test t pareado ($p \leq 0,05$). Considerando los resultados obtenidos, se puede afirmar que el individuo analizado presenta un patrón de marcha en agachamiento, ocurriendo una acentuada reducción de la amplitud de movimiento articular de la cadera, rodilla y tobillo ($p < 0,001$), además de la inexistencia de hiperextensión de la cadera, de la primera ola de flexión de rodilla y flexión plantar de tobillo durante el ciclo de la marcha. Por lo tanto, se cree que los resultados de este estudio puedan contribuir en posibles procesos de rehabilitación que sean realizados con el individuo analizado, siendo estos direccionados a las principales deficiencias del mismo. Se propone la realización de estudios similares, con varios individuos para verificar si estos datos pueden ser generalizados a otros portadores de esta patología.

PALABRAS-CLAVE: Parálisis Cerebral; Marcha Humana; Biomecánica.

ASPECTOS BIOMECÂNICOS DA MARCHA DE UM PORTADOR DE PARALISIA CEREBRAL

A paralisia cerebral (PC) é um distúrbio permanente e variável do movimento e da postura, causado por um dano no desenvolvimento do Sistema Nervoso Central no começo da vida. Desta maneira, este estudo de caso tem como objetivo descrever as características cinemáticas da marcha de um indivíduo portador de PC diplégica espástica e compará-las com o padrão de normalidade disponível na literatura. Para a análise cinemática da marcha foi utilizado um sistema de cinemetria 3D (DMAS 5.0), por meio do qual foram mensuradas variáveis angulares das articulações dos quadris, joelhos e tornozelos. Para comparar os dados da marcha do indivíduo analisado com os dados de normalidade disponíveis na literatura foi utilizado o teste t pareado ($p \leq 0,05$). Considerando os resultados obtidos, pode-se afirmar que o indivíduo analisado apresenta um padrão de marcha em agachamento, havendo uma acentuada redução da amplitude de movimentação articular de quadril, joelho e tornozelo ($p < 0,001$), além da inexistência da hiper-extensão de quadril, da primeira onda de flexão do joelho e da flexão plantar do tornozelo durante o ciclo da marcha. Desta maneira, acredita-se que os resultados deste estudo possam contribuir em possíveis processos reabilitativos a serem realizados com o indivíduo analisado, sendo estes direcionados às principais deficiências do mesmo. Sugere-se a realização de estudos similares, com vários indivíduos a fim de verificar se os presentes achados podem ser generalizados a outros portadores desta patologia.

PALAVRAS-CHAVE: Paralisia Cerebral; Marcha humana; Biomecânica.