98 - DESCRIPTIVE ANALYSIS OF CHILDREN GAIT IN AQUATIC ENVIRONMENT

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INTRODUCTION

The gait according to Hebert *et al*. [1], it is a set of movements rhythmic and alternated of the trunk and extremities aiming at to the locomotion of the body or its center of gravity for front. It is considered the most common and most complex of all human movements.This complex movement is acquired during infancy and the understanding of the standards of gait in the children depends on the complex interaction between growth and development[2] .

Sutherland et al.[3], it between the precursors of the biomechanics analysis of the infantile gait. It approached some factors that indicate the maturation of the gait as: the initial contact of the foot in the ground with the use of the heel, the presence of the call wave of flexion of the knee and the reciprocal sway of the inferior and superior members. In 1988, Sutherland et al [3] had more published one of the most known studies about the development of the gait that investigated the processes of change and maturation of the gait since the independent gait until the age of 7 years. From this study the authors had defined that the mature standard of the gait happens to the 3 years of age and the development of walking is completed in the age of 5 years. The gait of the children of 7 years of age is come close very to the adults and few differences are found.

Given to the importance of the process of acquisition and maturation of the gait of the child in development, it is necessary to describe how this movement occurs of the biomechanics point of view, under different ambient conditions to search the causes of the abnormalities and the optimization of the movement[4].

In the aquatic environment the gait is influenced by the push. The force push it opposes to the gravity force and reduces the apparent corporal weight. Consequently, it has reduction of the forces of compression in the joints, and the movements can be carried through more freely in the water. On the other hand, the drag force provides resistance to the movement, making it difficult and being able to reduce its speed. In compensation, such resistance can propitiate muscular strengthen and greater time for execution of the movements. Still, when somebody is put into motion against the resistance of the water, the aquatic environment is modified constantly, what it can improve the capacity of maintenance of the balance[5].

Of this form, the aquatic rehabilitation widely is used especially by the easiness that offers the child to alleviate the load on the joints and to increase its balance[6]. However little it is known on the real alterations of this movement in quantitative data, in relation to the biomechanics variable [7,8].

Inside of the biomechanics it has an area that it is destined to study the variables that involve the description of the movement, independent to the forces that cause this movement, is the kinematics. As Winter[9] the variable include linear and angular the displacements, speeds and accelerations. Because of this, the kinematic analysis is used to describe the standards of movement of the body as a whole or its segments. In this study just the angular variable will be boarded, within the accomplishment of a subjective analysis of the movement.

In accordance with David and Avila [7], the description of the movement curves can serve as reference in development studies or identification of pathologies and accompaniment of treatments. Having as base the lack of scientific evidences in the area, this study has as objective to provide inquiries through the qualitative analysis and of the kinematics variable of the children gait in the aquatic environment.

METHODS

This descriptive search of exploratory field was carried through together to the Laboratory of Research in Aquatic Biomechanics of the CEFID-UDESC. After the approval of the Committee of Ethics in Research in Human beings - UDESC, an explicative of the used procedures letter was directed to the parents, together with an assent term for accomplishment of the study.

Four children without apparent problem in the gait had participated of the research. Children 1 and 3 had respectively 11 and 12 years of age and were of the feminine sex. Children 2 and 4 had respectively 12 and 7 years of age and were of the masculine sex. Child 1 weighed 43,2kg and had 1,54 meters of height, child 2 weighed 51,4kg and measured 1.61 meters of height, child 3 weighed 56,6 kg and measured 1,54 meters of height and child 4 weighed 27,4kg and measured 1,30 meters of height.

The immersion level was adjusted for each child so that was next to the esterni bone. For this, steps had been placed underneath of the footbridge. Thus, the immersion level was in the manubrium for child 2, in 7ª rib for child 3, in the xiphoid process for child 1 and in 12ª ribs for child 4.

For the accomplishment of the kinematics analysis the children had been marked in the determinative anatomical points of the angles formed for the corporal segments of knee e ankle, being these: greater trochanter of femur, tibial plateau, lateral malleolus and fifth metatarsal head of the left leg with a permanent marking pen. After the markings the children had a time to make familiar themselves to the aquatic environment. The walk was carried through on one footbridge of 5.0m of length, in the speed most comfortable for the kids, chosen after adaptive training. Each child carried through 12 passages.

The images had been filmed in the sagittal plan for a camcorder that was located the 3,6 meters of the platforms of force inside of a sealed box located in one step to a height of 0,57m, being able to film the body of the child passing in the platforms. For video edition was used WinProducer 3 DVD version 3.1software from InterVideo®. For the analysis of the acquired images the software of the DgeeMe 1.2 system was used, that it is a package of software based on the captation of the images and for the analysis of the movement. The curves of angular displacement had been filtered in SAD 32 program using the Butterworth filter with a cut frequency of 30 Hz and order 3. An external gauge of dimensions 2m X 1,5m with markings to each 0,5m was used in this study. The gauge was previously filmed to the passage of each child. For the analysis of data was used the descriptive statistics by means of average, standard deviation and coefficient of variation, from the program Microsoft Excel.

RESULTS

In Figure 1.0 separately will be presented the average and standard deviation line of the angular displacement of the ankle of the four children.

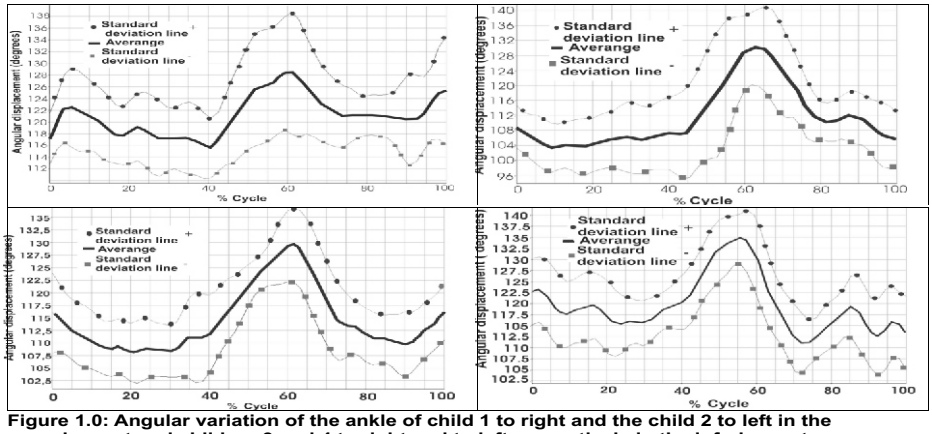

Figure 1.0: Angular variation of the ankle of child 1 to right and the child 2 to left in the superior part and children 3 and 4 to right and to left respectively in the inferior part.

In Figure 1.1 will be presented the average and standard deviation line of the angular displacement of the knee of the four children separately.

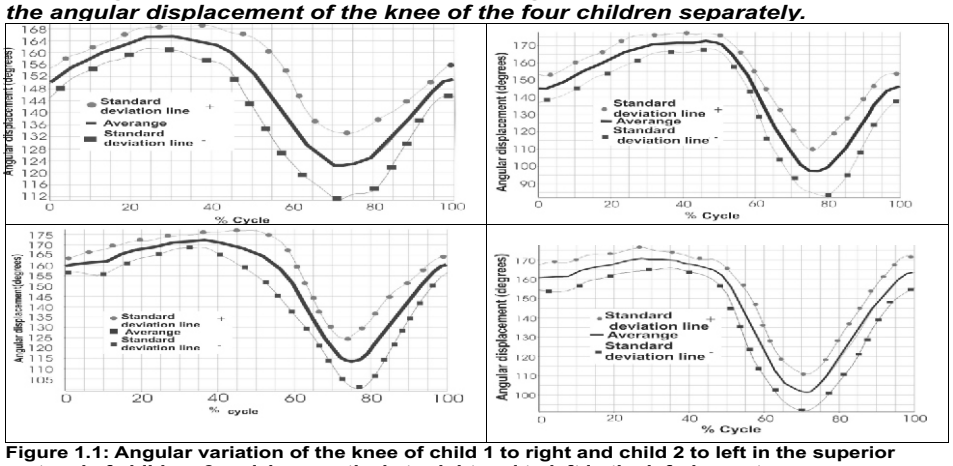

Figure 1.1: Angular variation of the knee of child 1 to right and child 2 to left in the superior part and of children 3 and 4 respectively to right and to left in the inferior part.

In Figure 1.2 will be presented average and standard deviation line of the angular displacement of the ankle and of the knee for all the children.

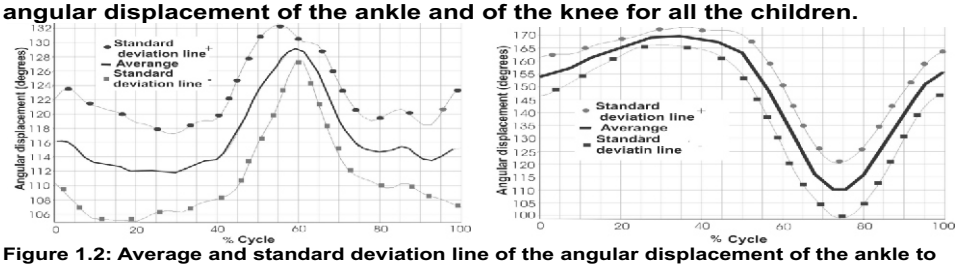

Figure 1.2: Average and standard deviation line of the angular displacement of the ankle to left and of the knee to right for all the children.

DISCUSSION

In this session had been argued the kinematics components and carried through a subjective gait analysis of the children.

a) Ankle: In the terrestrial environment is found 4 arcs of movement for the ankle. One knows that in the initial contact the ankle is found neutral (or in flexion plantar of 3° to 5°) and that a plantar flexion wave of the ankle happens during the phase of reply to the load of the cycle gait in the terrestrial environment, approximately in 12% of the cycle[8,10]. One observes in Figures 1,0 and 1.2 that this wave of the ankle plantar flexion does not happen during the phase of reply to the load in the aquatic environment. Thus, of the four arcs of movement existent in the ground gait, in the water it can be observed only 3.

One believe that the first wave of plantar flexion does not happen for the fact of all the children already touch the ground in the majority of the times with the plain foot on the soil. This fact corroborates with previous studies [5,11,12,13]. Barela et al. [14] studied the adults and aged gait in the aquatic environment and also it evidenced that the joint of the ankle of the adults and the aged ones was in flexion (dorsiflexion) in the terrestrial environment and practically in the neutral position in the aquatic environment in the phase of initial contact. Through the subjective analysis it was possible to observe that in the majority of the passages, the initial contact was carried through with the plain foot for all the children.

Of this form, it was possible to evidence that in the aquatic environment the positioning of the foot in the ground is different. This happens probably due to action of the push, the resistance of the aquatic way, the speed and to the length of the pace that is smaller not having enough time for the child to make the touch of the heel, in the attempt to keep a constant speed as requested [11,12,14].

The children 1 and 4 that were in a lesser level of immersion that the others two and had presented the curve of displacement of the ankle with bigger irregularities. These irregularities in the curve of the angular displacement of the ankle can have happened due to the biggest unbalance proportionated to the lesser level of immersion. Another factor that influenced directly in the morphology of the curves of angular displacement of the ankle of child 4 was the fact of this being newer than the other children and to present greater instability in the gait.

In the land, as Perry[8] the amplitude of movement of the ankle during the gait in the terrestrial environment is of 26°.

One observes in Figure 1.2 that the amplitude of movement of the ankle decreased in the aquatic environment, being around 17°. This fact can have happened due the biggest resistance that the children had to walk in the aquatic environment. However, Gehm et al [11], verified that the angular variation of the ADM (amplitude of movement) of the ankle was bigger in the aquatic environment in a study carried through with adults.

b) Knee: One observe in Figure 1.1 and 1.2 that the initial contact was carried through with the knee in 25° of flexion in the aquatic environment. Through the subjective analysis of the images also it was possible to observe that the children were carrying through the initial contact with bent knee. Fact that differs from the terrestrial environment where can happen a flexion of the knee of 5° [8]. One believe that the increase of the flexion is due to the more resistance of the water that makes it difficult the advance of the segment leg and to the force of push that facilitates the flexion of the knee, leading to the touch of the heel in the ground with the knee more bent that the observed one in land [12].

It had some similarities between the described curves for David and Avila [7], in a study carried through with children in the terrestrial environment and the found ones in this study. However, in the water the knee of the children passes for three arcs of movement in sagittal plan and not four as in the terrestrial environment. According to Rose and Gamble [10] and Perry [8], in the terrestrial environment the first wave of flexion of the knee must it to the absorption of the impact during the reply phase to the load. For the children of this study this first flexion didn't happen. This fact can be explained due the push force that reduces the impact in the joints, making with that the flexion of the knee during this phase is unnecessary [15,16].

The ADM (amplitude of movement) of the knee for adults and children in the terrestrial environment is of 50° to 60° [8,10]. For the children of this study the amplitude was of 60° in aquatic environment, Barela [5] also verified an ADM of 56° for the adults and 52° for the aged ones (also) in the aquatic environment.

CONCLUSION

From of these observing it can be evidenced that variations happen in the angular displacement of the ankle and knee when children of different ages are placed in different levels of immersion. The biggest alterations had happened during the phase of initial contact for both the segments, when the ankle met plain and the knee benter than in the terrestrial environment. Of the four existing arcs of movement in the terrestrial environment for the curve of angular displacement of the ankle and knee, in the water it was possible to observe only three.

When prescribing trainings of gait in the aquatic environment, besides lead in account the possibility that the way offers for trainings of balance and proprioception is important to establish the objective of the rehabilitation to control some variable as the immersion level, therefore the alteration of this must be controlled carefully from the daily evolution of the patient.

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DESCRIPTIVE ANALYSIS OF CHILDREN GAIT IN AQUATIC ENVIRONMENT

ABSTRACT

The objective of this study was to analyze the kinematics characteristics of children's gait in the aquatic environment. The march was described through the angular displacement of the knee and ankle and a qualitative analysis. The study happened in the swimming pool of the CEFID-UDESC, where four children of both the sexes with age varying between 7 and 12 years participated. The children had carried through 12 passages in one footbridge of 5 meters of length in a self - selected speed. The immersion level was in the manubrium for child number 2, in the 7th rib for child number 3, in the xiphoid process for child number 1 and in the 12th rib for child number 4. The children had only been filmed in the left side in the sagittal plan with a digital camcorder that was in a sealed box located at 3,6 meters of the footbridge in a height of 0,57 meters. For the analysis of the angular displacement had been marked the following anatomical marks: greater trochanter of femur, tibial plateau, lateral malleolus and fifth metatarsal head. For the analysis of data a descriptive statistics. The achieved data in this study had been compared with the found ones in literature referring to the terrestrial environment. It was possible to observe that the biggest alterations had occurred during the phase of initial contact, the ankle met plain and the knee in bigger flexion that in the terrestrial

environment. Of the four arcs of movement of the ankle and the knee, only 3 had been evidenced. Based on this analysis when prescribing the trainings of gait in the aquatic environment it is important to establish the objective of the rehabilitation at short, medium and long term to control some variable that influence in the movement as the level of immersion.

Key - words: aquatic environment, kinematic, children, gait training

ANALYSE DESCRIPTIVE DE LA MARCHE D´ENFANTS EN MILIEU AQUATIQUE

RESUME

L´objectif de cette étude fut d´analyser les caractéristiques cinématiques de la marche d´enfants en milieu aquatique. La marche a été décrite à travers le déplacement angulaire du genou et de la cheville et une analyse qualitative. L´étude a eu lieu dans la piscine du CEFID-UDESC, à laquelle quatre enfants des deux sexes, de 7 à 12 ans, ont participé. Les enfants ont réalisé 12 passages sur une passerelle de 5 mètres de long à une vitesse librement choisie. Le niveau d´immersion fut au manubrium pour l´enfant 2, à la 7e côtes pour l´enfant 4. Les enfants ont été filmés seulement du côté droit sur le plan sagittal par une caméra digitale placée dans une boîte étanche positionnée à 3,6 mètres de la passerelle à une hauteur de 0,57 mètres. Pour l´analyse du déplacement angulaire des points anatonmiques ont été marqués sur les membres inférieurs qui sont : le grand trochanter du fémur, le plateau du tibia, la malléole latérale et le cinquième métatarse. Pour l´analyse des données a été utilisée la statistique descriptive. Les données obtenues dans cette étude ont été comparées à celles rencontrées dans la littérature se rapportant au milieu terrestre. Il a été possible d´observer que les plus importantes altérations se sont produites pendant la phase de contact initial, la cheville se présentait plane et le genou en une plus grande flexion qu´en milieu terrestre. Des quatres arcs de mouvement de la cheville et du genou, 3 seulement furent constatés. En se basant sur cette analyse, quand est prescrit l´exercice de la marche en milieu aquatique, il est important de fixer l´objectif de la rééducation à court, moyen et long terme pour contrôler certaines variables qui influencent le mouvement comme le niveau d´immersion.

Mots-clés : milieu aquatique, cinémétrie, enfants, exercice de marche..

ANÁLISIS DESCRIPTIVO DE LA MARCHA DE NIÑOS EN UM AMBIENTE ACUÁTICO

RESUMEN

El objetivo de este estudio fue analizar las características cinemáticas de la marcha de los niños en un ambiente acuático. La marcha fue descripta a través del dislocamiento angular de la rodilla y tobillo por medio de un análisis cualitativo. El estudio fue realizado en una piscina del CEFID-UDESC, donde participaron cuatro niños de ambos sexos y con edad entre 7 y 12 años. Los niños realizaron 12 pasos en una pasarela de 5 metros de longitud en una velocidad auto elegida. El nivel de inmersión fue en el manúbrio para el nino 2, en la 7ª costilla para el niño 3, en el proceso xifoides para el niño 1 y en la 12ª costilla para el niño 4. Los niños fueron filmados solamente de lado izquierdo en el plano sagital por una cámara digital que estaba en una caja estanque posicionado a 3,6 metros de la pasarela en una altura de 0,57 metros. Para el análisis del dislocamiento angular fueron marcados puntos anatómicos en los miembros inferiores siguientes: El trocánter mayor del fémur, meseta tibial, maléolo lateral y quinto metatarso. Para el análisis de datos fue utilizada la estadística descriptiva. Los datos obtenidos en este estudio fueron comparados a los encontrados en la literatura referentes al ambiente terrestre. Fue posible observar que las mayores alteraciones ocurrieron durante la fase de contacto inicial, el tobillo se encontraba plano y la rodilla en mayor flexión que en ambiente terrestre. De los cuatros arcos de movimiento del tobillo y de la rodilla, se han constatado apenas 3. Basándose en ese análisis al prescribir el entrenamiento de marcha en el ambiente acuático es importante establecer el objetivo de la rehabilitación a corto, medio y largo plazo, para controlar algunas variables que influencian en el movimiento, como el nivel de inmersión.

Palabras - clave: ambiente acuático, cinemetria, niños, entrenamiento de la marcha.

ANÁLISE DESCRITIVA DA MARCHA DE CRIANÇAS NO AMBIENTE AQUÁTICO

RESUMO

O objetivo deste estudo foi analisar as características cinemáticas da marcha de crianças no ambiente aquático. A marcha foi descrita através do deslocamento angular do joelho e tornozelo e de uma análise qualitativa. O estudo aconteceu na piscina do CEFID-UDESC, onde participaram quatro crianças de ambos os sexos com idade variando entre 7 e 12 anos de idade. As crianças realizaram 12 passagens em uma passarela de 5 metros de comprimento numa velocidade auto-elegida. O nível de imersão foi no manúbrio para a criança 2, na 7ª costela para a criança 3, no processo xifóide para a criança 1 e na 12ª costelas para a criança 4. As crianças foram filmadas somente do lado esquerdo no plano sagital por uma filmadora digital que estava numa caixa estanque posicionada a 3,6 metros da passarela em uma altura de 0,57 metros. Para a análise do deslocamento angular foram marcados pontos anatômicos nos membros inferiores, sendo estes: o trocânter maior do fêmur, platô tibial, maléolo lateral e quinto metatarso. Para a análise de dados foi utilizada a estatística descritiva. Os dados obtidos neste estudo foram comparados aos encontrados na literatura referentes ao ambiente terrestre. Foi possível observar que as maiores alterações ocorreram durante a fase de contato inicial, o tornozelo encontrava-se plano e o joelho em maior flexão que no ambiente terrestre. Dos quatros arcos de movimento do tornozelo e do joelho, constataram-se apenas 3. Baseando-se nessa análise ao prescrever o treino de marcha no ambiente aquático é importante estabelecer o objetivo da reabilitação a curto, médio e longo prazo para controlar algumas variáveis que influenciam no movimento como o nível de imersão.

Palavras - chave: ambiente aquático, cinemetria, crianças, treino de marcha.