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AJUSTES POSTURAIS PRECOCES EM JOGADORES DE FUTEBOL COM PARALISIA CEREBRAL

EARLY POSTURAL ADJUSTMENTS IN FOOTBALL PLAYERS WITH CEREBRAL PALSY

AJUSTES POSTURALES PRECOCES EN JUGADORES DE FÚTBOL CON PARALISIA CEREBRAL

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RESUMO

Introdução: As limitações funcionais associadas aos quadros de Paralisia Cerebral (PC) e a inatividade estão diretamente relacionadas com o défice de controlo postural, nomeadamente dos *Early Postural Adjustments* (EPAs). Por outro lado, alguns estudos comprovam que a estabilidade pode ser melhorada através da prática de exercício físico.
Objetivos: O presente estudo teve como objetivos avaliar qual a influência do exercício, designadamente do futebol, em atletas com PC e a relação entre os EPAs e a oscilação postural.
Métodos: O estudo incluiu 5 jovens adultos masculinos com PC, com idades entre os 18 e os 36 anos, jogadores de futebol, classes 7 e 8. Registou-se a atividade eletromiográfica (*Delsys Trigno*) e calculou-se o rácio da musculatura postural [solear (SO) e tibial anterior (TA)] prévia ao movimento de semi-passo, bem como a amplitude de deslocamento do centro de pressão (CoP), através das plataformas de força (Bertec), antes e após um intervalo de 4 meses. Comparou-se momentos utilizando o teste de *Wilcoxon* e efetuou-se o cálculo da correlação de *Spearman* entre a amplitude de CoP e o rácio.
Procedeu-se ao recrutamento dos participantes num primeiro período em que estavam sem qualquer atividade física e nos 4 meses seguintes passaram a fazer treinos regulares, com uma frequência trissemanal e com uma duração de 1h30min, sempre realizados com o mesmo treinador e no mesmo espaço físico de treino.
Resultados: Verificou-se uma diminuição estatisticamente significativa da amplitude anterior do CoP (-4.47cm; p=0.043) ao fim de 4 meses, tendo-se verificado uma correlação negativa entre essa amplitude e o rácio do TA/SO (r=-0.90; p=0.037). No sentido médio-lateral observou-se uma diminuição de amplitude do CoP mínima (-1.49; p=0.893) e não se observou uma correlação estatisticamente significativa (r=0.10; p=0.873).
Conclusões: A prática desportiva, mesmo em patologia, tem efeitos significativos na melhoria da oscilação postural, havendo um aumento da relação entre a atividade muscular e o controlo postural.

Palavras-chave: Paralisia Cerebral; Early Postural Adjustments; Controlo Postural; Futebol.

ABSTRACT

Introduction: The functional limitations associated with Cerebral Palsy (CP) and inactivity are directly related to the deficit in postural control, namely the Early Postural Adjustments (EPAs). On the other hand, same studies showed that the practice of physical exercise can improve stability.
Objectives: Thus, the goal of the present study was to evaluate the influence of physical exercise, in this case in a football player, on the EPAs of athletes with CP.
Methods: The study included 5 young male adults with CP, aged between 18 and 36 years old, all football players, class 7 and 8.
The electromyographic activity was recorded using Delsys Trigno and the ratio of the postural musculature [soleus (SO) and tibialis anterior (TA)] prior to a step motion, as well as the center of pressure displacement amplitude were calculated through the force platforms (Bertec), before and after a 4 month interval of training. The two moments of evaluation were compared using the Wilcoxon test and the Spearman correlation between the CoP amplitude and the muscular activity ratio was calculated.
Participants were recruited in a first period in which they had no physical activity at all and in the following 4 months they started training regularly, with a frequency of three times a week for 1h30min, always with the same trainer and in the same physical training space.
Results: There was a statistically significant decrease in the anterior CoP amplitude (-4.47cm; p=0.043) after 4 months, with a negative correlation between this amplitude and the ratio of TA / SO (r=-0.90; p=0.037). In the lateral direction, a diminution of amplitude of minimum CoP (-1.49; p=0.893) without statistically significant correlation (r=0.10; p=0.873) was found.
Conclusions: Practicing sport, even in pathology, has a significant effect on the improvement of postural oscillation, with an increase in the relationship between muscular activity and postural control.

Keywords: Cerebral Palsy; Early Postural Adjustments; Postural Control; Football.

RESUMEN

Introducción: Las limitaciones funcionales asociadas a los cuadros de Parálisis Cerebral (PC) y la inactividad están directamente relacionadas con el déficit de control postural, en particular de los Early Postural Adjustments (EPA). Por otro lado, algunos estudios demuestran que la estabilidad puede ser mejorada a través de la práctica de ejercicio físico.
Objetivos: El presente estudio tuvo como objetivos evaluar cuál es la influencia del ejercicio, en particular en el fútbol, en atletas con PC y la relación entre los EPA y la oscilación postural.
Métodos: El estudio incluyó a 5 jóvenes adultos masculinos con PC, con edades entre 18 y 36, todos jugadores de fútbol, clase 7 y 8. Se registró la actividad electromiográfica (Delsys Trigno) y se calculó el ratio de la musculatura postural [solear (SO) y tibial anterior (TA)] previa al movimiento de semi-paso, bien como la amplitud de desplazamiento del centro de presión (CoP), a través

de las plataformas de fuerza (Bertec), antes y después de un intervalo de 4 meses. Se compararon momentos utilizando la prueba de Wilcoxon y se efectuó el cálculo de la correlación de Spearman entre la amplitud de CoP y el ratio. Se procedió al reclutamiento de los participantes en un primer período en que estaban sin ninguna actividad física; en los 4 meses siguientes empezaran a entrenar regularmente, con una frecuencia trisemanal y con una duración de 1h30min, siempre con el mismo entrenador y en el mismo espacio físico de entrenamiento.

Resultados: Se verificó una reducción estadísticamente significativa de la amplitud anterior del CoP (-4.47cm, p = 0.043) al cabo de 4 meses, habiéndose comprobado una correlación negativa entre esa amplitud y la relación del TA / SO (r = -0.90; p = 0,037). En el sentido medio-lateral se observó una reducción de amplitud del CoP mínima (-1.49; p = 0.893) y no se observó una correlación estadísticamente significativa (r = 0.10; p = 0.873).

Conclusiones: La práctica deportiva, incluso en patología, tiene efectos significativos en la mejora de la oscilación postural, con un aumento en la relación entre la actividad muscular y el control postural.

Palabras-clave: Parálisis cerebral; Early Postural Adjustments; Control Postural; Fútbol

INTRODUCTION

The Cerebral Palsy (CP) results in motor deficit and postural control resulting from damage to the developing brain. The disorder may be more or less severe depending on when the injury occurs and the location and severity of the associated problems (Colver, Fairhurst, & Pharoah 2014).

Individuals with PCs tend to have low levels of physical activity. As for the general population, when practiced by individuals with CP, physical activity can have great effects on health, especially in terms of gains regarding bone structure, cardiorespiratory and muscular conditioning (Keawutan, Bell, Davies, & Boyd, 2014).

However, during the literature review, there haven't been studies on the benefit of physical activity in individuals with CP, especially with regard to the development of postural control and in adulthood.

Postural control (PC) is considered a complex motor skill resulting from the interaction of various sensory-motor processes. The two main functional objectives of PC are postural orientation and postural balance (Vuillermea, Danionc, Forestier, & Nougier, 2002).

The maintenance of balance presupposes the existence of a movement strategy that is effective in controlling the centre of mass (CM). In the initiation of gait, the changes of the support conditions require an adjustment of the muscular activity on the part of the inferior members in order to maintain the posture and to control the CM in order to maintain the balance. These changes in muscle activity occur at the level of the postural muscles and arise in advance of the voluntary movement, which is called the feedforward mechanism. These are intended to maintain stability and balance, by means of the oscillations of the pressure centre (CoP) in order to keep the CM inside the support base. Changes in balance and postural control may induce inadequate responses to disturbances resulting in functional limitations most often (Mille, Johnson, Martinez, & Rogers, 2005).

Knowing that the inactivity and functional limitations that are associated with CP frames are directly related to postural control and that some studies in healthy individuals (Keawutan, Bell, Davies, & Boyd, 2014) prove that stability can be improved by practicing physical exercise, the present work was to evaluate the influence of physical exercise, in this case in a football player, on the EPAs of athletes with CP."

1. METHODS

1.1 Sample

The sample consisted of 5 male young adults between the ages of 18 and 36, soccer practitioners, class 7 and 8.

The inclusion criteria implied that it was an individual of at least 18 years old with the ability to perform autonomous gait without helpers and with the ability to understand orders (CPISRA 2014).

In the exclusion criteria it was defined that the individuals could not present secondary problems, such as, for example, epilepsy and intellectual disability, that is, Intelligence Quotient (IQ) <70 (Beckung, Steffenburg, & Uvebrant, 1997). They could not have undergone previous orthopedic surgeries nor had been submitted to botulinum toxin for less than 6 months (Pavone, et al., 2016) and they have not been used in other complementary therapies (eg.: physical therapy).

Data collection instruments and procedures

The participants were recruited into a football team. First, they had no physical activity at all; in the following 4 months they started training regularly three days a week for 1h30min, always with the same coach and in the same physical training space. Nutritional support was also provided to players specializing in the area throughout the sporting season. Data collection was done at the Laboratory of Biomechanics of the University of Porto (LABIOMEP). The task consisted in staying for 1 minute in a static

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position, followed by the walking movement. Video data collection (with the informed consent of each athlete) was performed through a Bertec camera (front plane) at a frequency of 10 Hz. Data were recorded on a computer in .AVI format for future viewing. Surface markers were also used in the main joints and 2 clusters on the thighs, as in figure 1. The follow-up of the movement of these markers was performed at a frequency of 200Hz.

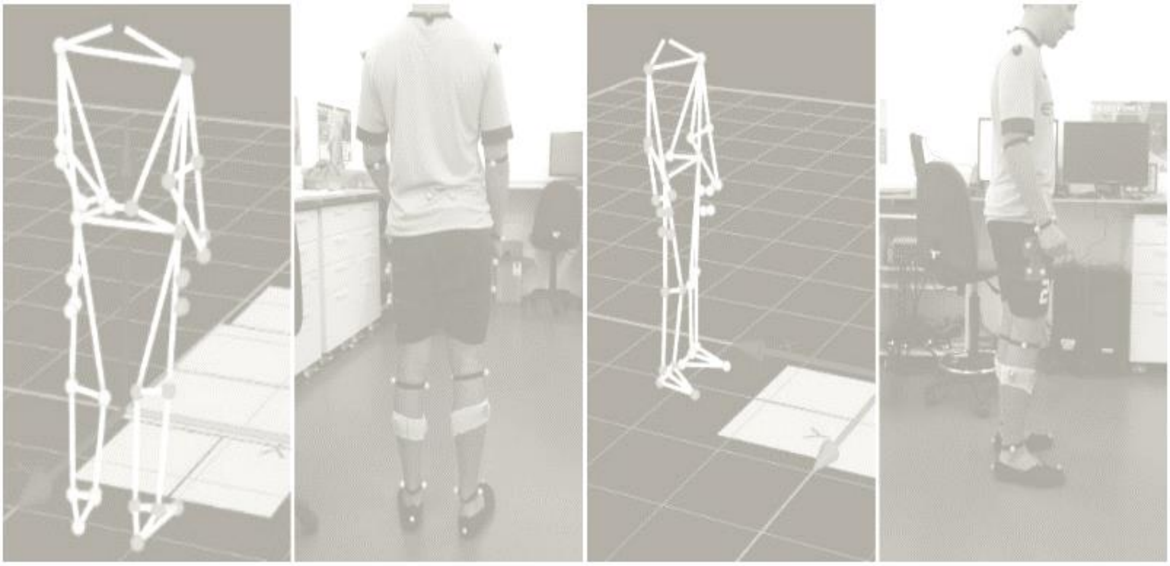

Figure 1: Image of the platforms of form (Bertec) and one of the individuals under study, in which one can also see the markers that were used in the main joints (Photographs taken with the author's consent).

Synchronized with the markers, surface electromyography (EMG) and force platform were also used, with signal collection at a frequency of 1000Hz. As for the EMG, just before the electrodes were placed it was necessary to prepare the skin in order to reduce the impedance of the electrode / skin assembly (Pezarat-Correia, Santos, & Veloso, 1993). The selected muscles were Femoral Reto (RF), Femoral Biceps (BF), Soleus (OS), Tibial Anterior (TA) and Lateral Gastrocnemius (GL). As the anatomical point identified for its placement, it was selected according to the recommendations of SENIAM (Surface ElectroMyoGraphy for the Non-Invasive Assessment of Muscles).
The individuals under study started the test in an upright position and fixing a stitch in front of the platform, in order to allow a static position that was comfortable, in order to obtain an EPA response with a sufficient magnitude for its reading. For according to Latash, EPAs are mitigated the more unstable the position assumed is. We then chose to let individuals assume a spontaneous position so as not to condition the APAs at the outset.
The experimental procedure involved 5 replicates to each subject. In order to prevent fatigue from settling in, as it slows the conduction speed and consequently an increase in the arrival of the EMG signal and in turn a late arrival of the response, intervals of at least 1 minute were made between repetitions. We opted for 1 minute on the platforms for the player to stabilize his posture in a static position before starting the task and allow a better reading of both platform and EMG data, this time being no reference value.
All the individuals under study used the same type of footwear, provided by the biomechanical laboratory to guarantee the non-bias of the results, since different types of soles cause different postural reactions (Sterzing, Frommhold, & Rosenbaum, 2016).

Kinematic data analysis
The beginning of movement or time zero (t0) was considered the first visible movement. However, since we were analyzing data in the order of milliseconds, it was necessary to find the exact moment at which the task was started; for this was correlated the visual reference given by the kinematic analysis with the first inflection of the vertical component of the reaction force of the soil. As seen below in figure 2, this is reflected in the curve before the first vertical inflection, when the curve begins to decrease to the minimum.

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Figure 2: Indication of the beginning of the weight transfer (- - - - -) and the beginning of the movement (———).

EMG signal analysis

The raw EMG signal and the force data were processed using the Matlab software, through specially developed routines. Thus, the raw EMG signal was filtered through a bandpass filter from 20 Hz to 500 Hz and processed using Root Mean Square (RMS). The signal from the force platforms was also filtered using a 10 Hz bandpass filter and force values were normalized for each subject's weight (Silva, et al., 2012).

The EPA interval was defined from -550ms to -150ms; the baseline for each muscle was considered as the average activity in the range of -800ms to -750ms. To quantify the electromyographic activity of each muscle the mean value of each muscle was used in each interval for the EPA.As for the normalization in the EPA and APA intervals, which were made by the baseline and summarized in the formulas: $\frac{EPAs}{baseline}$.

The analysis of muscle activity was quantified using the ratios between the Tibial Anterior (TA) and Solear (SO) and the mathematical expressions that were defined to calculate the ratios were as follows: $\frac{TA-SO}{TA+SO}$ e $\frac{RF-BF}{RF+BF}$. Which implies: the more positive the value, the more activity we have the TA or the more negative the value, the more activity we have the SO.

As for CoP, this was calculated according to the formula: $CoPml = \frac{Map}{-Fvt}$ e $= \frac{Mml}{Fvt}$.

1.2 Statiscal analysis

The electromyographic activity was recorded and the ratio of postural musculature [between soleus (SO) and anterior tibial (TA)] was calculated prior to the half-step movement, as well as the pressure center (CoP) amplitude, through power platforms and video system (Bertec program) before and after an interval of 4 months. Moments were compared using the Wilcoxon test and the Spearman correlation between the CoP amplitude and the ratio was calculated.

2. RESULTS

There was a statistically significant decrease in CoP amplitude (-4.47 cm; p = 0.043) at the end of 4 months, with a negative correlation between this amplitude and the ratio of TA / SO (r = -0.90, p = 0.037). In the mid-lateral direction (graph 2) there was a decrease in the minimum CoP amplitude (-1.49; p = 0.893) and no statistically significant correlation was observed (r = 0.10; p = 0.873).

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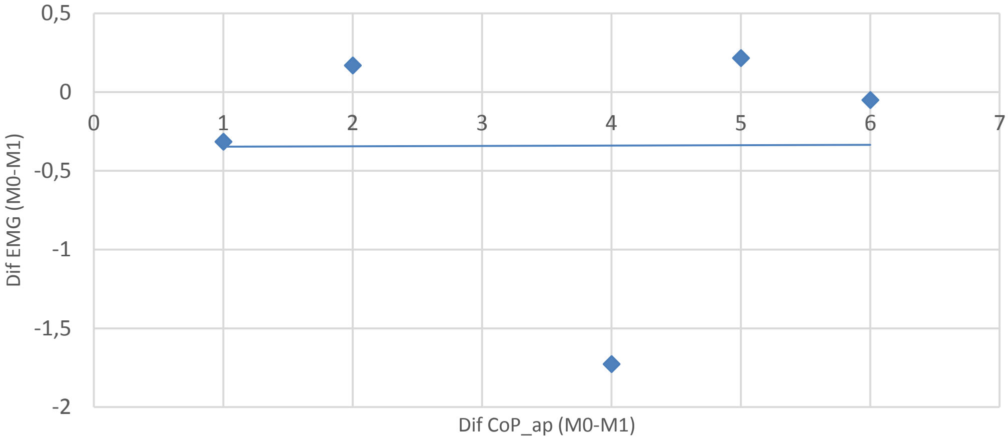
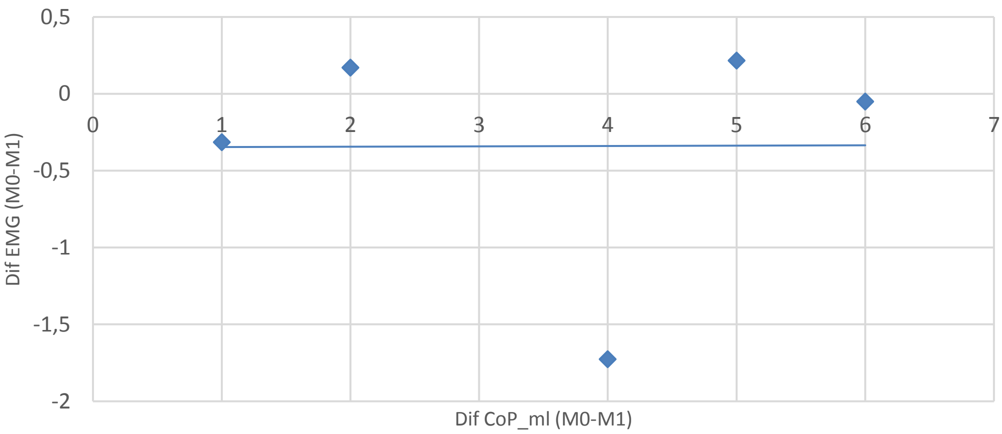
Graph 1 - Correlation between the difference of the first (M0) for the second moment (M1) of the anteroposterior Pressure Center (CoP) and the difference between the electromyography (EMG) activity from M0 to M1.



Graph 2 - Correlation between the difference between the first (M0) for the second moment (M1) of the Center of Pressure (CoP) and the difference between the activity of electromyography (EMG) from M0 to M1.



3. DISCUSSION

After analysis of our statistically significant results, we can first affirm that the higher the ratio between TA / SO is, the greater will be the AP displacement.

Since forward propulsion is controlled by the dorso-lateral system, the deficits demonstrated in the anteroposterior force (Tokuno & Eng, 2006) are probably related to the alteration in APAs in the SO muscle of the most affected limb during the onset of the march.

In fact, localized injuries in this region are typically associated with dysfunction of ventro-media systems, such as the cortico-reticular pathway, and may justify changes in the SO muscle activity of the most injured limb (Silva et al., 2012).

Malouin, Richards, & Durnas (2002) argue that there is weakness in the injured limb as a result of excessive co-activation of the dorsiflexor muscles (TA). In our study, the activity of TA (fascial muscle) is influenced by the reciprocal mechanism of inhibition of the SO muscle, formed by tonic fibers, which is highly dependent on the afferent Ib and II fibers to modulate their activity (Mazzaro, Nielson, Grey, & Sinkjaer, 2007).

However, we can say there was a decrease in the TA / SO ratio at the second moment, due to the increase in the SO activity (TT strategy) and was related to the lower AP displacement of CoP. That is, sporting practice (in this case soccer) improved the postural response reflecting an activation of the SO.

LIMITATION STUDY

The fact that it is only a sample containing male individuals alone is a disadvantage. In future studies, the care of selecting a second and third group (with women and healthy individuals), should be taken into account in order to evaluate the difference between normal and

pathological individuals, even in sports.
In addition to all these limitations, there is also the difficulty of not being numerous studies on the subject in question, thus limiting bibliographic support, both on the pathology of Cerebral Palsy and sports field.

CONCLUSIONS

We conclude that sports practice, even in pathology, causes changes in postural oscillation, with an increase in the relationship between muscular activity and postural control.
If with our results we can verify that there is indeed an improvement in the postural control with the sports practice, we can then state that the physical activity brings health benefits for people with pathology.
Giving this habit early on, that is, when they are still children, in the long term (as adults) they will have an improvement of their daily autonomy; also, in a multidisplient context the children are more easily included in an environment in which everyone (including other children without pathology) look at them the same way and do not exclude them socially because they have limitations in certain tasks. This, in turn, favours personal relationships and self-esteem. Even because sports has to be of all and for all. And this type of multidisciplinary approach turns out to be a preventive means in the health context, because it lowers the probability of the morbidities and physical limitations that are associated with the pathology.

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