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Using virtual reality for motor rehabilitation in a child with ataxic cerebral palsy: case report

Uso da realidade virtual na reabilitação motora de uma criança com Paralisia Cerebral Atáxica: estudo de caso

El uso de la realidad virtual en la rehabilitación motora de un niño con Parálisis Cerebral Ataxia: un estudio experimental

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ABSTRACT | Was evaluated the influence of Virtual Reality (VR) with Nintendo Wii (NW) on balance and gait of a children with ataxic cerebral palsy (CP-A). A case study, child male, 12 years, diagnosis of CP-A without history of respiratory, cardiac or orthopedic previous diseases, independent and preserved cognitive march, attended the premises of Amarati entity located in Jundiaí (SP). Initially the child was assessed by the Scale Berg, Kay Cerny Protocol and GMFM-66. After it started the rehabilitation using VR, 3 times a week in 30 minute sessions, through games of NW®, with the game Wii Fit Plus, Balance Board Wii Remote platform and control during 04 months, totaling 40 sessions. The child continued kinesiotherapeutic treatment within the institution during the collection period. With the end of the proposed period, the same parameters were reassessed. There was an increase in the GMFM-66 score with increasing average scores of 71.69 (SD 1.64) to 77.46 (SD 2.06) in the evolving dimensions "standing" and "walking, running and skip "; increase in scale Berg (from 48 to 53 points), indicating an improvement in static equilibrium; the protocol Kay Cerny shows no changes in the evaluated parameters (speed, frequency of steps/min, and last stride length and step width) were observed. These results suggest that the use of the NW influences the improvement mainly to balance the child when used in addition to the kinesiotherapeutic treatment, however is necessary to perform studies with larger populations for evidence of its effectiveness.

Keywords | Cerebral Palsy; Virtual Reality Exposure Therapy; Physical Therapy Modalities

RESUMO | Avaliou-se a influência da Realidade Virtual (RV) com Nintendo Wii (NW) no equilíbrio e na marcha de uma criança com Paralisia Cerebral Atáxica (PC-A). O trabalho é um estudo de caso com uma criança do gênero masculino, 12 anos, diagnosticada com PC-A, sem antecedentes de doenças respiratórias, cardíacas ou ortopédicas prévias, marcha independente e cognitivo preservado, atendida nas dependências da entidade Amarati, localizada em Jundiaí (SP). Inicialmente a criança foi avaliada pela escala de Berg, Protocolo de Kay Cerny, e GMFM-66. Depois se iniciou a reabilitação utilizando a RV 3 vezes por semana em sessões de até 30 minutos, através dos jogos do NW®, com o jogo *Wii Fit plus*, plataforma *Balance Board* e controle *Wii Remote* durante 04 meses, totalizando 40 sessões. A criança continuou o tratamento cinesioterapêutico na própria instituição durante o período de coleta. Com o término do período proposto, os mesmos parâmetros foram reavaliados. Observou-se aumento na pontuação da GMFM-66 com aumento do escore médio de 71,69 (SD 1,64) para 77,46 (SD 2,06), evoluindo nas dimensões "em pé" e "andar, correr e pular"; aumento na Escala de Berg (de 48 para 53 pontos), indicando melhora no equilíbrio estático; não foram observadas mudanças no protocolo de Kay Cerny nos parâmetros avaliados (velocidade, frequência de passos/min, comprimento do passo e passada e largura do passo). Os resultados apresentados sugerem que o uso do NW influencia na melhora principalmente do equilíbrio da criança quando usada em complemento com o tratamento cinesioterapêutico, porém é necessária a realização de estudos com populações maiores para comprovação de sua eficácia.

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Descritores | Paralisia Cerebral; Terapia de Exposição à Realidade Virtual; Modalidades de Fisioterapia Fisioterapia.

RESUMEN | Se ha evaluado la influencia de la Realidad Virtual (RV) con Nintendo WII (NW) para el equilibrio y la marcha de un niño con Parálisis Cerebral Ataxia (PC-A). Este trabajo es un estudio de caso con niño de 12 años de edad, diagnosticado con PC-A, sin antecedentes de enfermedades respiratorias, cardíacas u ortopédicas previas, marcha independiente y cognitivo preservado, que era asistido en las dependencias de una entidad Amarati, ubicada en Jundiaí (SP), Brasil. Al inicio, se evaluó el niño por la Escala de Berg, por el Protocolo de Kay Cerny, y por GMFM-66. Enseguida, tuvo inicio la rehabilitación con el uso de la RV 3 veces por semana en sesiones hasta 30 minutos de duración, a través de los juegos del NW®, con el juego *Wii Fit plus*, plataforma *Balance Board* y control *Wii Remote* durante 04 meses, con un total de 40 sesiones. El niño siguió el tratamiento con kinesioterapia en la propia institución durante el periodo de la recolección. Con el término del periodo propuesto, los mismos parámetros se han reevaluados. Se observó el aumento en la puntuación de la GMFM-66 con una subida de la puntuación media de 71,69 (SD 1,64) para 77,46 (SD 2,06), la evolución en las dimensiones "de pie" y "andar, correr y saltar"; el aumento en la Escala de Berg (de 48 para 53 puntos), lo que indica una mejora en el equilibrio estático; no se han observado cambios en el protocolo de Kay Cerny en los parámetros evaluados (velocidad, frecuencia de pasos/min, extensión del paso y de la pasada y anchura del paso). Los resultados presentados muestran que el uso del NW hace una influencia en la mejora, en especial, del equilibrio del niño cuando se usa en complementación al tratamiento con kinesioterapia, pero es necesaria la realización de estudios con poblaciones mayores para comprobar su eficacia.
Palabras clave | Parálisis Cerebral; Terapia de Exposición Mediante Realidad Virtual; Modalidades de Fisioterapia.

INTRODUCTION

Cerebral Palsy (CP) is defined as a set of motor disorders caused by central nervous system dysfunctions, these cause changes in muscle tone and posture in a non-progressive way due to fetal malformation or some brain damage, with symptoms precipitating during the first few years of life, until around 3 to 5 years of age[1-3].

There are different modes of classifying types of CP, the most frequently of which encountered in the literature are based on the location and type of motor change[1,3]. Among these, spastic cerebral palsy is the most common, with it being characterized by an increase in muscle tone, hyperreflexia, and slowness of movement[1,2]; dyskinetic CP is characterized by involuntary movements, with fluctuating muscle tone; ataxic CP is primarily characterized by the presence of axial and appendicular ataxia, hypotonia, dysmetria and gait with an increased base[2,3]; and hypotonic CP, which is not recognized by many authors who consider it to be a transitional phase for spasticity[1]. Another classification can be subdivided according to the location of the impairment, such as hemiparetic diplegic and quadriparetic CP[1-4].

In order to optimize the functionality of these children, new techniques that complement physiotherapeutic treatment are presently used, such as Virtual Reality (VR). This techniques involves creating a fully three-dimensional virtual environment, where the patient interacts through visual, auditory, tactile and sensory stimulation, thereby recreating the most accurate reality possible; this is widely used for rehabilitating gait, balance and motor coordination, among others[6,7,5]. Some of the main benefits are: increased motivation to be involved in treatment, immediate feedback, ability to save performed activities on the computer, high patient interactivity, which provides the fun which is associated with rehabilitation in several age-groups, in addition to promoting physical and cognitive performance improvement[5,7,8].

Video games, due to their low cost, are the most commonly used equipment in the rehabilitation process, the most notable being the Nintendo® Wii (NW)[7,8,9]. Being widely used in orthopaedic and neurological rehabilitation, the platform brings benefits such as effectiveness in maximal oxygen intake, improvement in physical conditioning, balance, posture, movement amplitude, in addition to creating patient motivation[5,7,9,10].

Thus, considering that the use of VR in therapies with neurological patients is increasingly common in rehabilitation clinics and represents a field that has yet to be extensively explored, the aim of this study was to evaluate the influence of VR with the NW on static, dynamic and gait balance of a child diagnosed with Ataxic Cerebral Palsy (ACP).

METHODOLOGY

Sample

The paper is a prospective, longitudinal – and descriptive-type case study, approved by the Ethics in Research Committee at the Centro Universitário Padre Anchieta under directive nº 262,499/2013, authorized by the child's legal guardians by means of signed informed consent. A 12-year-old male child, diagnosed with clinical ACP, GMFCS level II, was included in the study. The child had cognitive preservation and independent gait with auxiliary devices, albeit with difficulties to run, jump, climb and descend steps that are associated with the balance disorders that are apparent during these exercises. The child had no previous respiratory, cardiac or orthopedic diseases, and received his attention at the Amarati organization, Jundiaí (SP).

Procedure

The subject was initially submitted to evaluations in accordance with the Berg Balance Scale (BBS) so as to analyze static balance[11]; the Kay Cerny protocol was used for kinematic analysis of the gait[12]; and the Gross Motor Function Measure 66 (GMFM-66)[13] to analyze the gross global motricity[11,12,13].

Following the completion of these assessments, the intervention began with the NW and the Wii Fit plus game, played on the balance board platform, together with the Wii Remote. The treatment was performed in 30-minute morning sessions, 3 times per week over 4 months, totaling 40 sessions. The subject continued the floor kinesiotherapy treatment once a week, at the Amarati institution, where the child worked on the gait, balance and motor coordination.

During the NW sessions, the following 12 games were used: on the odd-numbered days the games played were 'Hula Hoop' (pelvic girdle mobilization and weight bearing), 'Mon Way® Circuit' (stem displacement, center of gravity perception and extensor chain muscle strength), 'Basic Step' (weight transfer, coordination and muscle strength of lower limbs, secondary training to gait), 'Obstacle Course' (gait, balance, postural adjustments and muscle strength of lower limbs), 'Soccer Heading' (laterolateral weight bearing and motor coordination) and 'Balance Bubble' (anteroposterior and laterolateral weight bearing, along with balance). Whereas on even-numbered days the games were 'Skateboard Arena' (anteroposterior weight bearing, gross motor skills and balance), 'Table Tilt' (anteroposterior and laterolateral weight bearing, along with postural adjustment and attention), 'Twist Torso' (torso rotation, balance), 'Tight Rope Walk' (weight bearing, balance, postural adjustments), 'Penguin Slide' (weight bearing) and 'Basic Run' (gait and muscle strength of lower limbs, used with the aid of a strong elastic band (Carci Band) around the abdominal region, placed below the ribs and above the anterior superior iliac crests).

Before the games began, there was a 30-second period of passive stretching exercises, namely of the dorsal decubitus, the flexor muscles, hip and knee extensors, bilateral plantiflexors and dorsiflexors.

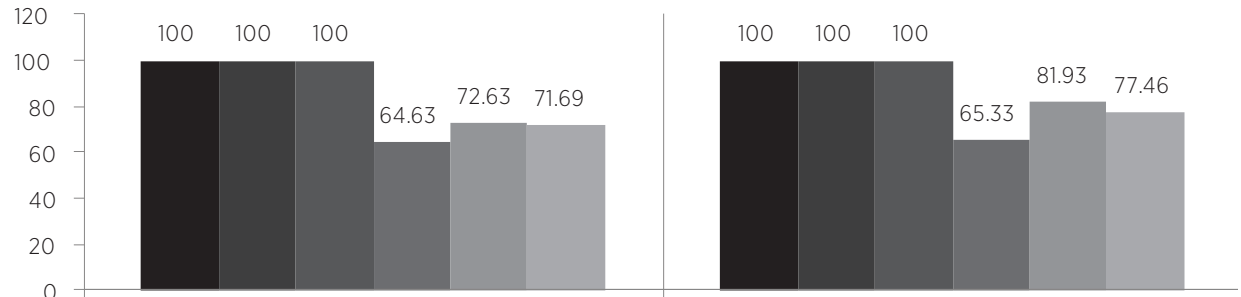
After the proposed period, the same parameters were evaluated. The data were arranged in tables and charts so as to perform descriptive analyses and compare the initial and final results.

RESULTS

According to the GMFM-66, there was an increase in the mean score from 71.69 (±1.64) to 77.46 (±2.06), with progression in the D dimensions "standing" (score increase from 64.63 (±1.41) to 65.33 (±1.41) and "walking, running and jumping" (score increase from 72.63 (±1.7) to 81.93 (±2.53), as presented in Figure 1.

Table 1 shows data regarding balance, which displays an increase in total score from 48 to 53 points, with most of the progress in items that require the subject to reach forward with outstretched arm while remaining standing, turning around and looking back over the shoulder while remaining standing, position alternating feet on the step without support and standing on one leg.

When assessing the gait kinematics through the Kay Cerny Protocol and only tabulating the data obtained within the 6 meters of the central area's walkway, figure 2 shows that no changes were observed in the analyzed parameters (step number, length, and width, average speed and frequency of steps/min).



	Before Treatment	After Treatment
Dimension A	100	100
Dimension B	100	100
Dimension C	100	100
Dimension D	64.63	65.33
Dimension E	72.63	81.93
TOTAL	71.69	77.46

Figure 1. GMFM-66 scores before and after VR treatment. Data in absolute values

Table 1. BBS score before and after treatment. Data in absolute values and percentage of total gain

EVALUATED ITEMS	INITIAL SCORE	FINAL SCORE
Sitting to standing	4	4
Standing 2 min without support	4	4
Sitting without support	4	4
Standing to sitting	4	4
Transfers	4	4
Standing, without support, with eyes closed	4	4
Standing, without support, with feet together	4	4
Reaching forward	**3**	**4**
Retrieving an object from the floor	4	4
Looking back over the shoulders	**2**	**4**
Turning 360°	4	4
Alternating feet on a step and standing without support	3	4
Standing, with one foot in front of the other without support	3	3
Standing on one leg	**1**	**2**
TOTAL SCORE	48	53
IMPROVEMENT PERCENTAGE	**10.41%**	

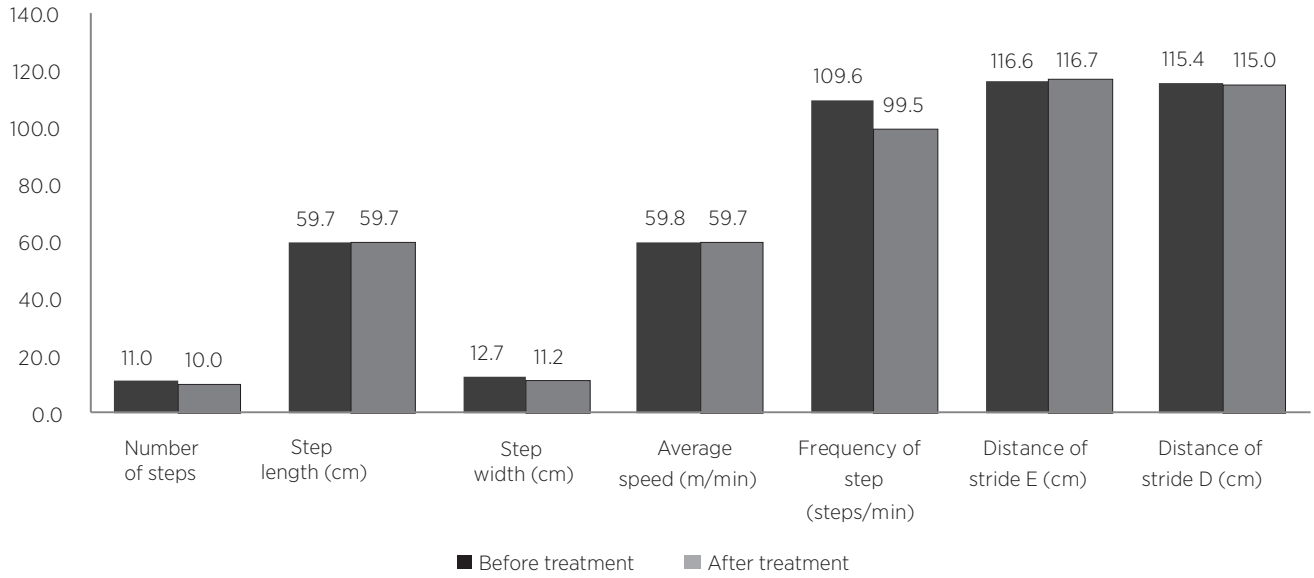


Figure 2. Representation of results obtained by the Kay Cerny protocol. Data in absolute values

DISCUSSION

Children with APC are characterized by the presence of hypotonia and dysmetria, which hinders their balance and movement coordination[3]. Rehabilitation becomes vital so that these children can have adequate functionality during day-to-day activities. Treatment is often a long-term affair, which can often become monotonous, tiresome and demotivating. Including VR in the treatment can provide several benefits, some of which have already been proven by scientific studies[5,14-16].

After VR training, this study showed there to be an increase in the GMFM-66 scores, mainly in dimensions D and E, where there was improvement in squatting, raising the right foot, taking a step over a knee-hight stick, making 10 consecutive steps between rows separated by 20cm, and running 4m.

There was also an increase in score observed in the BBS, specifically in the items that require standing on one leg, climbing stairs using alternating feet without the support of upper limbs, looking back over the shoulders and standing, with an outstretched arm, reaching forward. This was probably a result of undertaking the activities involved in the video game, where characteristics were worked on such as motor coordination, agility, weight displacement and bearing, postural adjustments, balance, torso rotation, lower limb muscle strength (MMII) in a playful and interactive way.

Other studies have also proved that using VR provides functional improvement in neurological patients. According to Deutsch, et al.[5], CP patients showed improvement in visual perception, postural control, center of gravity alignment and more symmetrical medial-lateral weight distribution after rehabilitation with VR[5]. In another study performed by Tavares, et al.[14] on patients with spastic diplegia cerebral palsy using the NW to complement physiotherapy over 20 sessions, there was also a general improvement observed in the children's functionality evaluated by GMFM, in addition to improved balance, as determined by the Pediatric Balance Scale (modified version of the Berg Balance Scale)[14].

Schiavinato, et al.[17] reported an improvement in the balance of patients with cerebellar dysfunction, assessed using the Berg scale, after 10 rehabilitation sessions with NW. Other studies that used VR as an intervention during rehabilitation in patients with other diseases, such as Cerebrovascular Accidents and Parkinson's Disease, also presented satisfactory results, with improvement in balance and gait kinematics[15,16], thus confirming the results presented in this study.

While analyzing the improvements obtained in the GMFM-66 and in the BBS, the items that were carried out with a better performance correlated, as is shown in items where the subject had to stay on one leg and alternate steps to climb the stairs without support.

The results from this did not indicate changes in the gait kinematic parameters, which was probably because the games used in the treatment worked the gait as secondary action, with the focus being on balance and weight displacement in a static way. Given a larger number of subjects, a longer period of intervention and isolated VR treatment that is not associated to floor physiotherapy may result in significant data that would prove the actual effect of this kind of treatment solely on gait kinematics.

CONCLUSION

Using VR during treatment of a child with ACP can be of a beneficial nature, this is because it seems that there is a beneficial influence in terms of improving the child's functionality when used as a complement to kinesiotherapeutic treatment, principally in his or her static and dynamic balance. However, further study with a larger population is necessary in order to find real proof regarding its effectiveness.

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