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CASE STUDIES

Virtual occupational therapy in a child with cerebral palsy

Terapia ocupațională virtuală la un copil cu paralizie cerebrală infantilă

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Abstract

Background. Virtual occupational therapy using adapted Movement-Based Interactive Video Games and the Microsoft's Kinect Xbox 360® sensor of motion is a promising new therapy for children with cerebral palsy.

Aims. To follow the evolution of a child with cerebral palsy who benefited from long-term virtual occupational therapy.

Methods. We report the evolution of a 7-year-old girl with cerebral palsy stage I GMFCS and stage I MACS presenting with left hemiparesis predominant in the lower limb, who played MIRA interactive video games using the Kinect Xbox sensor for 14 months, with a frequency of 3 sessions/week and a duration of 30 minutes/session. During this period, she also benefited from conventional therapy for cerebral palsy (kinesiotherapy, hydrokinesiotherapy and conventional occupational therapy).

Results. At the final visit, the child no longer neglected her left side, the spasticity on the triceps surae muscle decreased from 2 to 1+ on the Modified Ashworth Scale, heel strike on her left foot was possible with the use of orthopaedic shoes and a hinged ankle foot orthosis, and the child acquired unipodal balance on the left foot for 10 seconds. The ABILHAND-kids score improved from 37 to 39 points (4.76% amendment), the QUEST score improved from 95.52 to 97.76 (2.24% amendment) and the Pediatric Balance Scale improved from 49 to 54 points (9.25% amendment). Both parents and the child considered the new method as "very efficient" (5 points out of 5) at the final satisfaction questionnaire. No adverse effect of the exergaming was reported during 14 months of follow-up.

Conclusions. Long-term virtual occupational therapy associated with the conventional rehabilitation program improved motor function and performance in a child with cerebral palsy and hemiparesis. Virtual occupational therapy was well tolerated, showing no adverse effects after 14 months. The child enjoyed playing MIRA interactive video games, ensuring a good compliance to treatment.

Key words: virtual occupational therapy, cerebral palsy, kinect sensor, interactive video games

Rezumat

Premize. Terapia ocupațională virtuală, folosind jocuri video interactive adaptate copiilor cu dizabilități neuromotorii și senzorul de mișcare Kinect Xbox 360, este o metodă nouă și promițătoare în tratamentul copiilor cu paralizie cerebrală infantilă.

Obiective. Urmărirea evoluției unei fetițe cu paralizie cerebrale infantilă care a beneficiat pe termen lung de terapie ocupațională virtuală.

Metode. Prezentăm cazul unei fetițe în vârstă de 7 ani, cu paralizie cerebrală infantilă stadiul I GMFCS, stadiul I MACS, cu hemipareză stangă predominant crurală, care s-a jucat pe platforma MIRA de jocuri video interactive, folosind senzorul de mișcare Kinect Xbox 360 pe o perioadă de 14 luni, cu o frecvență de 3 sesiuni/săptămână, cu o durată de 30 de minute/sesiune. În această perioadă, ea a beneficiat și de terapia convențională pentru paralizia cerebrală infantilă (kinetoterapie, hidrokinetoterapie și terapie ocupațională convențională).

Rezultate. La consultația finală, fetița nu mai prezenta hemineglijență stângă, spasticitatea tricepsului sural a scăzut de la 2 la 1+ pe scala Ashworth modificată, atacul solului cu talonul era posibil în stânga, cu ajutorul ghetelor ortopedice și a ortezei de picior mobilă, iar sprijinul unipodal stâng a fost achiziționat, fiind posibil pentru maxim 10 secunde. Scorul ABILHAND-kids s-a îmbunătățit de la 37 la 39 de puncte (4,76% ameliorare), scorul QUEST s-a îmbunătățit de la 95,52 la 97,76 (2,24% ameliorare), iar scorul Pediatric Balance Scale s-a îmbunătățit de la 49 la 54 de puncte (9,25% ameliorare). Atât părinții, cât și fetița au considerat metoda ca fiind "foarte eficientă" (nota 5 din 5) la chestionarul de autosatisfacție de la final. Nici o reacție adversă nu a fost raportată după 14 luni de terapie ocupațională virtuală.

Concluzii. Terapia ocupațională virtuală aplicată pe termen lung, alături de programul convențional de recuperare, a îmbunătățit performanțele motorii și funcționalitatea la o fetiță cu paralizie cerebrală infantilă. Terapia a fost bine tolerată, fără nici un efect advers pe o perioadă de 14 luni. Jocurile din platforma MIRA au fost distractive, acest lucru asigurând o bună complianță la acest tip de tratament,

Cuvinte cheie: terapie ocupațională virtuală, paralizie cerebrală infantilă, jocuri video interactive.

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Introduction

Play is a central part in a child's life. Novel sensors of motion such as the Kinect Xbox® sensor permits the child to play video games and move at the same time. Tasks seen in these movement-based interactive video games (MBIVG) resemble the tasks used in conventional occupational therapy for children with neurological impairments. The amount of performed limb movements calculated with accelerometers during MBIVG sessions proved to be three times higher than during conventional rehabilitation therapy sessions in children with cerebral palsy (Zoccolillo et al., 2015). An energy expenditure was also reported in disabled persons who benefited from MBIVG (Deutsch et al., 2015).

Recent studies suggest that MBIVG are a very engaging and motivating type of therapy (Green & Wilson, 2012). Besides being a highly motivational therapy, one of the main advantages of therapy with interactive video games is the possibility of using it at home (Sevick et al., 2016).

Being fun and motivational, the method is very well accepted by children, and seems to be effective in improving arm motor control, functional status, activities of daily living (ADLs) and balance in children with cerebral palsy (Zoccolillo et al., 2015; Luna-Oliva et al., 2013; Winkels et al., 2013; Tarakci et al., 2013; Gordon et al., 2012).

An improvement of the Gross Motor Function Measure (GMFM) was reported in children with cerebral palsy (CP) who had played MBIVG for 8 weeks (Camara Machado et al., 2016).

However, children with neurological impairments need games that are adapted to their neurological performance in order to avoid the frustration caused by the impossibility of accomplishing tasks that a healthy child would easily perform (Pool et al., 2016). For this reason, MIRA REHAB has developed clinically based video exergames as a tool for rehabilitation therapy containing exercises that have the potential to improve motor function.

The purpose of this study was to describe the evolution of a cerebral palsy patient presenting with left hemiparesis during her treatment which included MIRA exergames with Kinect Xbox® sensor for a period of 14 months.

Hypothesis

Virtual occupational therapy could be a new efficient method in the treatment of children with cerebral palsy.

Material and methods

The intervention was approved by the Ethics Committee on Human Research of the "Iuliu Haţieganu" University of Medicine, Cluj-Napoca, Romania. The child's parents authorized her participation in the study by signing a free and informed consent form.

Research protocol

a) Period and place of the research

From October 2014 to December 2015, the patient attended a complex rehabilitation program in the "Maria Beatrice" Socio-Medical Services Complex, Alba-Iulia.

b) Subject

STI is a 7-year-old girl, diagnosed with left spastic hemiparesis CP, level I according to the Gross Motor Function Classification System (GMFCS) and level I according to the Manual Ability Classification System (MACS), caused by a hypoxic-ischemic injury at birth. She also suffers from hypermetropic astigmatism and convergent strabismus.

MRI, performed at the age of 2, revealed periventricular leukomalacia in the right hemisphere.

At the first visit, in October 2014, she complained of difficulty in running, jumping, climbing stairs and difficulty in playing games that require bimanual abilities and coordination.

On clinical examination, the Babinski sign was positive on the left side, deep tendon reflexes were asymmetric, exaggerated on the left side, and moderate spasticity, quantified as 2 on the Modified Ashworth Scale, was noticed for the triceps surae muscle. Discrete dyskinesia was also recorded in the left hand. The patient predominantly used her right hand, with a tendency to ignore the left hand. Fine motor tasks could be performed with both hands, however with a moderate difficulty with the left hand. She was able to walk independently, but heel strike was impossible on the left side. She was able to run, but at a slow speed. Unipodal balance and jumping on the left foot were impossible.

At the age of one, the child started a physical therapy program consisting of kinesiotherapy, the Bobath neurodevelopment method, 5 sessions/week, hydrokinesiotherapy, 2 sessions/week, and occupational therapy, 2 sessions/week.

c) Tests applied

The initial ABILHAND-kids score was 37 of a maximum of 42, the initial QUEST score was 95.52 from a total of 100, and the initial Pediatric Balance Scale was 49 out of a maximum of 56.

Since October 2014, the patient benefited from the new virtual occupational therapy method, using the MIRA platform and the Xbox Microsoft Kinect sensor.

The interactive video games from the MIRA platform were played for 30 minutes per session, 3 times/week, from October 2014 to December 2015.

In cooperation with rehabilitation professionals (rehabilitation physician, physiotherapist, occupational therapist and psychologist), a new scoring system for the quantification of upper limb motor function and performance called MIRA testing schedule was developed. It comprises 3 games from the MIRA platform (Move, Follow, Catch), played with each hand for two minutes (Fig. 1). This score proved to be a valid and reliable testing tool in our previous study (Moldovan et al., 2014).

Results

At the final visit, the child showed improved motor skills, she was able to run and climb stairs without any assistance and no longer complained of difficulty in playing games that require bimanual abilities and coordination. She no longer neglected her left side. Attention and visual-spatial skills were also improved. Spasticity in the triceps surae muscle decreased to 1+ on the Modified Ashworth Scale. Heel strike on her left foot was possible with the use of orthopaedic shoes and a hinged ankle foot orthosis. Independent finger movements of the left hand remained impossible, unipodal balance on the left foot was possible

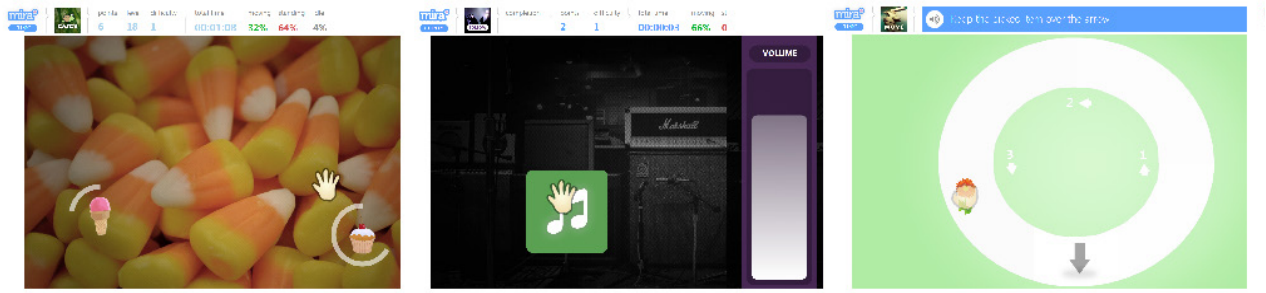

Fig. 1 – Snapshots of the MIRA video games; in order: Catch, Follow and Move - circle path.

for less than 10 seconds, and jumping on one foot was still impossible.

The final ABILHAND-kids score improved from 37 to 39 points (4.76% amendment), the QUEST score improved from 95.52 to 97.76 (2.24% amendment) and the Pediatric Balance Scale improved from 49 to 54 points (9.25% amendment) (Table I).

Table I

The evolution of motor function tests during the study.

Score	Initial score	Final score	Amendment	Maximum of the scale
ABILHAND-kids	37	39	4.76%	42
QUEST	95.52	97.76	2.24%	100
Pediatric Balance Scale	49	54	9.25%	56
MIRA testing schedule	1489	1895	33.31%	–

The points achieved in the MIRA testing schedule improved over time, from 1489 to 1895 (33.31% amendment), as shown in Fig. 2. Both parents and the child considered the new method as "very efficient" (5 points out of 5) at the final satisfaction questionnaire.

No adverse effect of exergaming was reported during 14 months of follow-up.

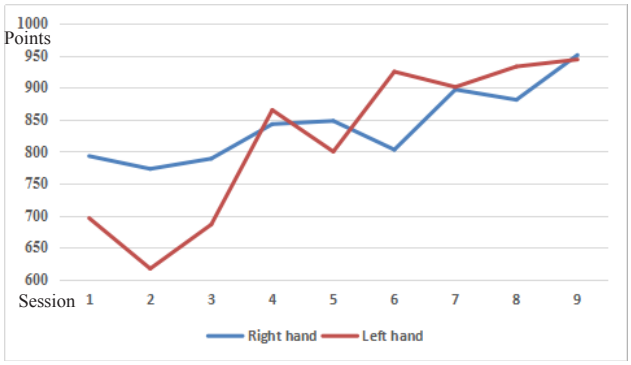

Fig. 2 – Evolution of the score (total points) for the left and the right hand, gained in the MIRA testing schedule during 9 sessions of evaluation

Discussions

MIRA games using the Kinect Xbox sensor train gross motor skills of the upper and lower limbs, balance and coordination of the body, visual-spatial ability, eye-hand coordination, attention, and limit spatial neglect. All these areas improved in the child during 14 months of follow-up. The amelioration noticed at the clinical examination was sustained by the improvement in the four assessments applied. The main progress achieved after one year of rehabilitation was in the field of balance and coordination.

MIRA testing schedule showed the highest improvement of the four assessments (33.31%). Initially, the score for the left upper limb was much lower than for the right upper limb due to lower motor control and spatial neglect of the left side. As MBIVG focused on the left upper limb, after 3 months of training, the score for the left hand was even better than the one for the right hand. Consequently, both sides were trained and the final scores showed equal performance for both sides.

Due to its high performance in identifying joint movements, it is generally accepted that the Kinect sensor can be used to assess the range of motion movements of the upper and lower limbs (Guess et al., 2016; Seo et al., 2016; Lahner et al., 2015; Hawi et al., 2014). Thus, it could also be used to assess motor performance in disabled persons (Rammer et al., 2014; Rocha et al., 2014).

The Kinect sensor provides analytical data that are hardly noticed by the clinician's eyes such as speed of the movement (average and maximum speed), acceleration (average and maximum acceleration) and total 3D distance of movements. It also provides functional data such as the total points gained in MIRA games. Since task achievement is rewarded with points, the score (total points) seems to quantify the function and performance of the limbs. However, achieving tasks also requires balance, visual-spatial coordination, hand-eye coordination, attention, a satisfactory IQ and a good visual acuity.

The MIRA platform provides adapted games for children with neurological impairments. Exergames are appreciated by both children and parents, and we consider them to be a promising new tool for rehabilitation professionals in the treatment of CP children.

The MIRA testing schedule is, to our knowledge, the first virtual assessment for the function and the performance of the upper limbs in children with CP. It seems to be a valid and reliable testing tool in our experience, but larger studies are needed to consolidate our findings.

Currently, there are no long-term studies in the literature regarding the effect of MBIVG over time in children with CP. The child in the current case study showed a constant clinical improvement during the 14-month follow-up, with no adverse effect.

Conclusions

1. Long-term virtual occupational therapy associated with a conventional rehabilitation program improved

motor function and performance in a child with cerebral palsy and hemiparesis.

2. Virtual occupational therapy was well tolerated, showing no adverse effects after 14 months.

3. The child enjoyed playing MIRA interactive video games, which ensured a good compliance to the treatment.

Conflicts of interest

There are no conflicts of interest.

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