EVALUATION OF SPATIOTEMPORAL PARAMETERS OF REACHING MOVEMENT BEFORE AND AFTER GAMETHERAPY IN A CHILD WITH DOWN SYNDROME: A CASE STUDY

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ABSTRACT

This study aimed to evaluate the spatiotemporal parameters of upper limb (UL) reaching movement in a child with Down syndrome (DS) before and after the application of gametherapy. Three-dimensional motion analysis was performed using the SMART-D 140 system (BTS, Milan, Italy), which enables kinematic evaluation of movement, focusing in this project on upper limb reaching. Gametherapy was applied through a playful memory game (GENIUS) in touchscreen mode. The results suggest that the use of virtual reality, such as the Genius game, can be effective in improving motor performance in individuals with Down syndrome, with potential applications in rehabilitation, although further research is needed in this field.

Keywords: Down syndrome; Motion analysis; Upper limb; Kinematics; Gametherapy.

INTRODUCTION

Down syndrome (DS) is a genetic condition characterized by chromosomal abnormality. It is recognized as the leading cause of intellectual disability and one of the most frequent numerical anomalies of autosomal chromosomes.

Functionality in children with DS is reduced compared with peers without this diagnosis. Hypotonia is present in 99% of cases, and early development is impaired due to insufficient descending impulses that command motor neurons in the spinal cord. Evidence already exists regarding the motor and cognitive performance characteristics of individuals with DS.

Several instruments are available to assess and describe functionality, particularly of the upper limb (UL), in the pediatric population. These tools assist in measuring impairment levels, avoiding subjectivity of self-reporting. Compared to

clinical evaluation scales, kinematic studies offer sensitive and quantitative assessment of abnormal motor performance components.

Gametherapy has emerged in the physical and cognitive rehabilitation of several pathological conditions, using video games and virtual reality to engage patients in therapeutic activities through a playful and motivational approach, improving adherence to treatment and clinical outcomes. Recent studies have shown that gametherapy may be effective in rehabilitation of patients with neurological conditions, improving mobility, balance, and motor coordination.

This case study aimed to evaluate the spatiotemporal parameters of upper limb reaching movement in a child with Down syndrome before and after gametherapy.

METHODOLOGY

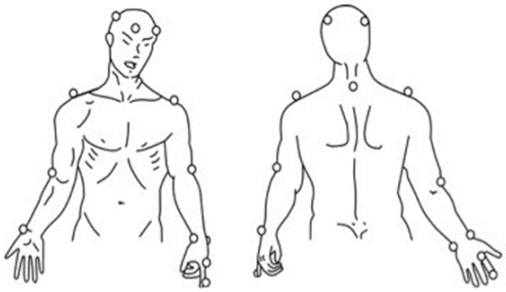
A child with DS, aged 15 years, able to understand and collaborate with the procedures, and presenting motor coordination difficulties in the upper limbs, was selected. Exclusion criteria included history of surgeries in the past 12 months, severe orthopedic deformities in the upper limbs or spine, epilepsy, or use of hearing aids. The child signed an assent form, and the guardians authorized participation through informed consent. The study was approved by the Ethics Committee of Universidade Evangélica de Goiás – UniEVANGÉLICA (Opinion number: 5.628.137).

Avaluation

Three-Dimensional Upper Limb Motion Analysis

After screening and anthropometric measurement, the SMART-D 140 system (BTS, Milan, Italy) was used. Reflective markers were positioned according to the SMARTup protocol: experimental setup (Figure 1).

Figure 1. Placement of markers for three-dimensional analysis using SMARTup: experimental configuration.



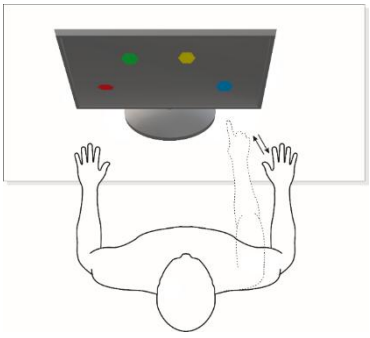
Fonte: FEUERSTEIN, R. 1980

Intervention

Gametherapy

Through a memory game (GENIUS) in touchscreen mode, the child performed an upper limb reaching task associated with a cognitive task of memorization and attention for 20 minutes (Figure 2).

Figure 2. Playful memory game – GENIUS



Fonte: próprios autores

RESULTS

The data were processed using protocols developed by SmartAnalyser (BTS, Milan, Italy). The following parameters were computed: duration of each phase, total duration, mean velocity, and maximum velocity, as shown in Table 1.

Improvements were observed in motor control, especially in the non-dominant arm, where there was a significant reduction in the reaching phase and an increase in movement efficiency (total duration), as well as in mean and maximum velocity. In the dominant arm, improvements were also noted, with a slight decrease in maximum velocity and efficiency, suggesting more refined motor control and smoother movements.

Table 1. Spatiotemporal parameters

Parâmetro	Braço Direito (Pré)	Braço Esquerdo (Pré)	Braço Direito (Pós)	Braço Esquerdo (Pós)
Distância (cm)	42	42	42	42
Fase de ida (s)	0,8 ± 0	1,58 ± 0	0.64 ± 0	0,65 ± 0
Fase de ajuste (s)	0,08 ± 0	0,42 ± 0	0.1 ± 0	0,21 ± 0
Fase de retorno (s)	0,71 ± 0	0,73 ± 0	0.75 ± 0	0,57 ± 0
Duração total (s)	1,127 ± 0	2,164 ± 0	0.853 ± 0	1,14 ± 0
Velocidade média (m/s)	1,719 ± 0	0,967 ± 0	1.46 ± 0	1,378 ± 0
Velocidade máxima (m/s)	2,947 ± 0	2,029 ± 0,531	2,431 ± 0	2,32 ± 0

Fonte: próprios autores

CONCLUSION

The use of virtual reality may be effective in improving motor performance in individuals with Down syndrome, with potential applications in rehabilitation. However, further research is needed in this area.

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