



Case Report

Virtual Rehabilitation and Spinal Cord Injury: Case Report

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Abstract

Introduction Virtual Reality (VR) is a trending, widely accessible, contemporary technology of increasing utility to biomedical and health applications. Medical rehabilitation represents one of the most recent fields to benefit from the advances in VR technology.

Case Report A chronic SCI patient, used three dimensional VR to improve their activities of daily living (ADL) and integrate traditional personal rehabilitation program. D Wall tecnoBody SRL is a hi-tech digital mirror that allows you to perform each motor gesture with maximum control. It makes it possible to analyze the performance in real-time according to precise parameters. Feedback mode helps to make the patient more aware of their body during the exercises and enables them to self-regulate without the need for feedback screens.

Conclusions This paper demonstrates how people with a spinal cord injury (SCI) can benefit from the innovative VR techniques.

Keywords: Rehabilitation; Spinal Cord Injury; Virtual Reality

Introduction

Effective communication is a central clinical function in building a therapeutic doctor-patient relationship, which is at the heart of medicine. The patient's information, involvement in decision-making, and effective communication assume an essential role in this contest [1]. Paradoxically, the digital space can feel like a protected both to the patient and to the doctor. It is a space where only the patient, story and doctor exist. Both the physical world and VR exist in Three Dimensions (3D) D-Wall TecnoBody [2] allows one to perform each gesture with maximum control, and makes it possible to analyze the performance in real-time according to precise parameters. Every action in front of D-Wall provides immediate bio-feedback. The 3D display can feasibly provide all necessary depth cues and feedback that helps patients develop control over their movements similar mirror. A primary candidate

for treatment using these methods would be patients suffering from Spinal Cord Injury (SCI). Typical causes of spinal cord damage are trauma, disease, or congenital disorders. Following a spinal cord injury, the rehabilitation process normally begins in the acute care phase. A primary goal of rehabilitation after illness or injury is to restore the physical functioning of an individual to the greatest possible extent. This aim to evaluate the impact of VR on patients with SCI, focusing on rehabilitation, return to functional status and awareness of self.

Case Report

40-year-old woman presented with complete paraplegia in a D5 level traumatic spinal cord injury . She was treated with vertebral stabilization. The American Spinal Injury Association (ASIA) classified spinal cord injury either complete or incomplete. [3] The ASIA scale grades patients from A to E based on their functional impairment. ASIA classified this particular case report

as A represents the greatest impairment state and likely E represents the normal condition. In 2002 clinical status of the patient was complicated by a spontaneous right hip dislocation, likely caused by spasms. This was treated with a hip replacement. In 2015, the patient presented with a peri-prosthetic stress fracture of the right femur, which was treated with osteosynthesis. On physical examination on June 11, 2021, the patient presented as alert and oriented with intact cranial nerve function. Motor and sensitivity functions were preserved in upper limbs. Lower limbs presented with complete paraplegia. Frequent spontaneous muscle spasms were observed on the right quadriceps, and moderate hypertonus was identified bilaterally at the hip abductor muscles. Range of Motion (ROM) of the right coxo-femoral articulation was limited to two thirds because of trigger pain in the extreme internal rotation. ROM of both knees was in the normal range. The patient maintained the seated position in their wheelchair with good trunk control. They could autonomously move from the chair to the bed despite the presence of left-convex thoracic scoliosis. The sensitive level was located at D5. (Table 1) Bladder function was impaired. The patient was unable to empty her bladder and voided through the use of intervalar catheterization [4]. A home-based rehabilitation program aimed to improve the patient's motor performance, their level of autonomy and control of pain and spasticity. The patient was educated on stretching the lower limbs and training postural movement. D-Wall virtual rehabilitation was proposed in place of traditional rehabilitation treatments once a week. The operator had access to useful programs in the D-Wall software. These include programs for joint mobility recovery, muscle strengthening in post-acute affected body segments, training for load management, and occupational therapy. During the rehabilitation the patient's family or physiotherapist can set up 19 different programs with three difficulty levels-easy, medium, or hard. These enabled the patient to work within their optimal range. The case report patient performed the exercises in her personal wheelchair. The exercises included upper limb and trunk mobilisation games and virtual game (Figure 1).

Evaluation	Right	Left
Level of injury	D5	D5
Muscle strength	plegia	plegia
Deep-Tendon Reflex (ROT)	Absent	Absent
Spontaneous muscle spasms	quadriceps	quadriceps
Range of Motion (ROM)	Limited on the hip (two thirds)	Limited on the hip (two thirds)
Grade of spasticity Ashworth Scale	4	2
Sensory	Absent under D5 level	Absent under D5 level

Discussion

Modern VR is no simple technology, nor merely a relevant phenomenon in the field of communications. Rather it is a "revolution" in progress. It is space entered into any other space, be it human, social, political, scientific, industrial or ludic. VR is configured as a complex process of "cultural change", which is increasingly establishing an epochal turning point in human history [5]. In this context, the doctor is also changing his figure, his role, his presence in society, and his relationship with the patient. VR has the potential to replace the daily life of an individual. Through the digital screen, people can communicate, learn and buy, personal i-Pad becomes their window to the world and communication becomes easier. In a D-Wall session a physiotherapist can control the patient during virtual exercises and an explanation of how to execute the exercises can be shown via realistic imaging on the digital screen. 3D product presentations enable a higher level of interactivity and clarity than traditional media [6]. The patient became more involved in the rehabilitation program and reported heightened awareness of the effects of physical activity. Communication using digital techniques resulted in instant interaction on the patient participation, decentralisation, and less hierarchical processing. The aim of the rehabilitation program was to improve the patient's autonomy in carrying out ADL. Therefore the educational content had to be clear and effective. Within the software modules the physiotherapist can utilise multiple different programs and games. They can choose preferred games such as: cut fruits, library or ski. In these games, the patient felt like the protagonist in the VR simulation and her motivation was influenced by the desire to win. At the end of the session she reported heightened feelings of well-being and enthusiasm because she won the game. Young people said that playing video games helps them to build social connections both in real life and online. The researchers noted that stronger communication and social connections improved



Figure 1: Case report during virtual rehabilitation: library game.

mental well-being [7]. There are many advantages associated VR. The same VR hardware can be used for various categories of patients, as well as for different types of exercises done by them. Disabled patient use the same virtual games in VR of healthy individuals. This is an important step in overcoming disability (Table 2). During the execution of the exercises, the patient could correct her posture on her own using the biofeedback presented in D-Wall digital mirror. It served as a digital support to enable awareness of posture control case report patient was in the chronic disability at 23 years after the trauma. In this phase of SCI trunk control is important for the maintenance of autonomy and to allow safe transitions in and out of the wheelchair [8]. The exercises were chosen to improve the level of autonomy, and to address to different tasks and needs of the individual. VR treatment proved to be complementary to traditional rehabilitation techniques. It facilitated the improvement of the individual's level of bodily, domestic, social, and sports-related. The patient's level of fatigue decreased noticeably after engaging the VR rehabilitation programs. This was due to the general improvement in physical fitness [9]. The D-Wall digital mirror provides a snapshot of the users' strengths and weaknesses because of the objective biofeedback and real-time data provided by the software. This is essential for structuring personalized training aimed at overcoming the functional limits of the individual.

1. Quality of Rehabilitation program: Very bad program <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input checked="" type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 Very good program
2. Quality of life: Influence <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 No influence
3. Satisfaction: Dissatisfaction <input type="checkbox"/> 0 <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input checked="" type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 Satisfaction

Conclusion

VR technology put the case report patient at the centre of a self-functional-evaluation it enabled her to be actively involved in the decision-making processes and allowed for effective communication between her and her care provider [10] Digital

assessment allows the patient to maintain the central role in communicating between the operator and the doctor. D-Wall TecnoBody SRL allows patient to perform each gesture with maximum control, and to share the results with the operator (Table 2) VR could be a complementary tool in the arsenal of the traditional rehabilitation program. It should be noted that these results are not representative, but point to a relationship that is worth exploring in a larger research group.

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