Annual Review of Cybertherapy and Telemedicine 2013
B.K. Wiederhold and G. Riva (Eds.)

Virtual Reality as a Method For Evaluation And Therapy After Traumatic Hand Surgery

Adriana Sarah NICA[1,2], Consuela Monica BRAILESCU[1,2], Rodica Gabriela SCARLET[1,2]
[1]*National Institute for Rehabilitation, Physical Medicine and Balneology Bucharest, Romania*
[2]*Physical Medicine and Rehabilitation Department, ,,Carol Davila" University of General Medicine and Pharmacy, Bucharest, Romania*

Abstract. In the last decade, Virtual Reality has encountered a continuous development concerning medical purposes and there are a lot of devices based on the classic ,, cyberglove" concept that are used as new therapeutic method for upper limb pathology, especially neurologic problems [1 ;2;3]. One of the VR devices is Pablo (Tyromotion), with very sensitive sensors that can measure the hand grip strenght and the pinch force, also the ROM (range of motion) for all the joints of the upper limb (shoulder, elbow, wrist) and offering the possibility of interactive games based on Virtual Reality concept with application in occupational therapy programs. We used Pablo in our study on patients with hand surgery as an objective tool for assessment and as additional therapeutic method to the classic Rehabilitation program [4; 5]. The results of the study proved that Pablo represents a modern option for evaluation of hand deficits and dysfunctions, with objective measurement replacement of classic goniometry and dynamometry, with computerized data base of patients with monitoring of parameters during the recovery program and with better muscular and neuro-cognitive feedback during the interactive therapeutic modules.

Keywords: Virtual Reality; Hand Surgery; Hand Evaluation and Therapy; PABLO"device; Functional Rehabilitation

Introduction

The post-traumatic hand surgery sequelaes represents an important part of pathology who addresses to a Hand Rehabilitation Center, not only from statistic percentages, but especially because of the major dysfunctionalities and handicaps for daily and professional activities. The causes of the hand traumatic injuries are very complex (burns, amputations, electric lessions, work-related accidents) and most of them require surgical intervention; after surgery, depending upon the severity of the sequelaes, the patients are integrated in a Rehabilitation program in a Hand Center. For establishing the therapeutic management of the patients, the doctors need to evaluate all the post-surgical sequelaes, especially neurologic sensitive and motor deficits, muscle force and joint mobility, but also the functional status of the patient (hand grip strenght, pinch force). The Pablo system from Tyromotion [1;2] is a new

device with very sensitive sensors that can measure the hand grip strenght and the pinch force, also the ROM (range of motion) for all the joints of the upper limb (shoulder, elbow, wrist). These measurements allows the PRM doctor to have an objective evaluation of joint mobility and muscular strenght of the entire upper limb, with better clinical and functional diagnosis for specific pathologies and with better computerised evaluation during the rehabilitation programs. Figure 1 [1] shows an example of the computerised evaluation of the ROM –eg for extension.

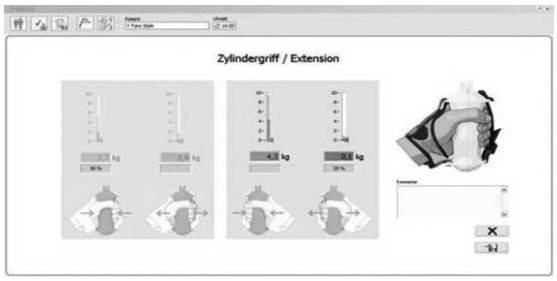

Figure 1. Computerised evaluation of ROM using Pablo

1. Purpose

We started to use Pablo in our Clinique of National Institute of Rehabilitation for patients hospitalised here after hand surgeries for various hand traumas. Our purpose was to demonstrate that Pablo can be useful as an assessment tool for hand pathology (instead of classic goniometry and dynamometry) also, that it can be part of the classic rehabilitation program for these patients (together with other specific therapeutic methods). [3;4;5]

2. Material and Method

The study was performed between May 2011 – October 2012 on 54 patients hospitalised here with complex sequelaes after hand surgery for traumatic injuries. At the beginning and at the end of each ten-days rehabilitation sessions in our Clinique, all of them were assessed clinical, pain score (VAS and McGill score) neurologic (specific sensitive and motor testings), classic goniometry and dynamometry (Jamar hand test) and also, using Pablo. The functional measurements consists in FIM scale (functional independence measurement), DASH score (Disability of Arm-Shoulder-Hand Score), Michigan score (Michigan Hand Outcomes Questionnaire) and dexterity and coordination test (using the 9-hole Peg board test) [5;6;7]. The rehabilitation program consisted in daily physical procedures for all the patients, with kinetics, occupational therapy, therapeutic massage, electric stimulations for hypotrophic muscles (the classic program). There was a group of 15 patients who had the whole classic program, but also an hour per day with Pablo therapy module. Figure 2 shows a young patient with surgery for a traumatic lesion in the wrist region working with Pablo as an adjuvant ergotherapy to the classic occupational therapy.

Figure 2. Ergotherapy using Pablo

Figure 3. Balloon game

Pablo offers the possibility of interactive sessions of occupational therapy based on Virtual Reality principles [3;4], representing a continuity of the standard possibilities for ergotherapy from the Hand Center, with adjustment for each patient clinical status and task-oriented based on usual daily activities and profession. The doctor or the kineto-therapist selects for each session the movement parameters, the strength and the grip/pinch that could be achieved by the patient based on realistic and accurate evaluation of ROM and muscular force (performed also with Pablo) and selects the most fitted „virtual game" to the clinical deficit of the patient. After training and daily performance using the device, the patient himself learn to adjust the parameters and the program may be performed at home as a continuation of the classic ergotherapy performed under supervision at the Hand Rehabilitation Center [5;6;7]**.** There are many games, each of them with specific target („Baloon" as shown in Figure 3 [1] is for improving eye-hand coordination, „Firefighters" enhances mobility and strength, etc).

3. Results

The study is completely finished; the statistic analysis of all individual assessments (clinic tests and Pablo soft database) was based on MicrosoftExcel, Kynos Modalisa, t-student test, chi ^{2} test and ANOVA and showed the following results:

- For pain and all local sequelaes (oedemas, vascular and trophic disturbancies) [8] the results showed improvement for all the studied patients, but no statistic significance for the Pablo group
- For coordination and dexterity: statistic significant better results for the Pablo group, with 32% better results at the 9-hole Peg board test
- For functional tests: all the patients integrated in Rehabilitation program improved the functionality for the operated hand and decreased the disability score, but the differences between the results at the patients who had Pablo therapy were statistic significant better versus those who didn't work with Pablo, as shown on the evolution of the Michigan score (377.9 points versus 355.1points). The improvement of the FIM score with 4.3 points at the end o the study comparing with its beginning, at patients who worked additional with Pablo, has an important functional and clinic implication: a greater measure of functional independence for the patient, better performance for daily activities and better chances for social and economic re-integration. Figure 4 shows 39.4 points improvement for the

DASH score at the patients who worked with Pablo versus 32.6 points at the patients who didn't work with Pablo.

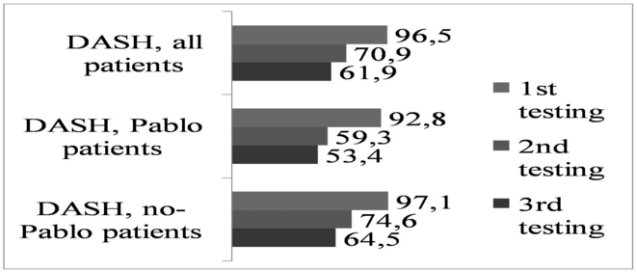

Figure 4. DASH score evolution during treatment

- For prehension, all the 10 types of grips and pinches evaluated with Pablo showed essential improvement for all the patients, but with significant improvement for those patients who worked with Pablo, as shown in Figure 5: the grip force flexion, policis-index finger, policis-medius finger and tri-digital pinch, which are the grips with the greatest practical and functional importance for daily activities (eating, dressing, manipulating objects).

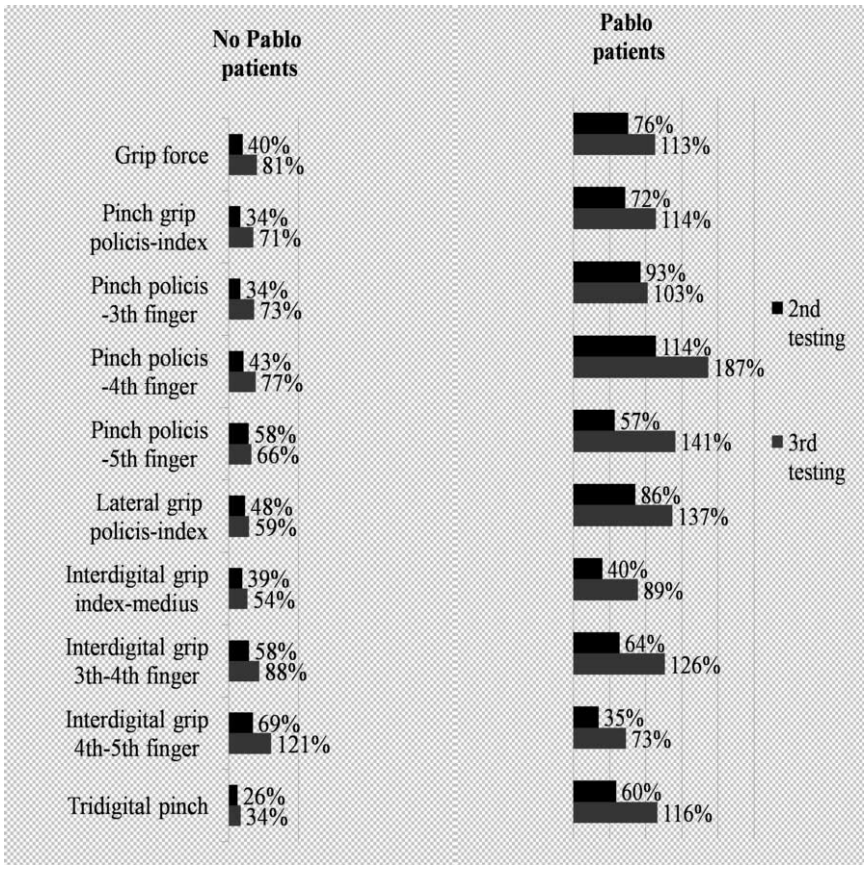

Figure 5. Grips and pinches evolution during treatment

4. Conclusions

- Pablo is a device that allows better, more objective and more rapid assessment of joints and strength of all upper limb segments, including prehension assessment with greater possibility for clinical and functional evaluation of a patient with hand pathology. The results are memorized in a computerized data-base for each patient, allowing the PRM specialists for objectively monitoring the progression in time of the recovery process [6; 7].
- Pablo game therapy sessions represents a continuation of the classical occupational therapy program that can be performed also by the patient himself, at home and they give the opportunity to adapt the game parameters to the realistic functional status of the patient. The benefits are on improving not only locomotor values (ROM, force, prehension), but also attention, motivation, dexterity, based on audio-visual and haptic feedback that can help the patient from early recovery process [6;7].
- Pablo can improve the results of the classic Rehabilitation program and can be integrated in Occupational Therapy methods only as a supplement, but not a substitute and only under professional medical supervision.

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