Virtual reality rehabilitation of the upper limb in chronic stroke: two case studies

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The Northern Ireland Chest Heart And Stroke Association

Introduction

- Poor recovery of upper limb function post stroke
  - Lesion site and size
  - Learned non-use
  - Adaptive changes
    - Neurological
    - Musculoskeletal
  - General Px inactivity
  - Limited % of treatment time

Introduction

- Why might VR be of use in upper limb stroke rehabilitation.
  - Intensive, task related practice
  - Active functional tasks
  - Motivation and enriched environments
  - Neural reorganisation of cerebral cortex
- Immersive / non—immersive VR.
  - Sense of presence / side-effects

Aim

- To investigate whether training in a virtual environment would effect motor activity or function in the more affected arm.
- To explore the clinical profile of two patients and their user experience of a VR system.
- To trial the feasibility of the VR training protocol prior to commencing an RCT.

Method

- Two single subject designs evaluated the user experience and motor activity / function pre- and post- training and at 6 week follow-up.
- Each person undertook a three-week training programme using the VR system that consisted of three 30-minute sessions per week.

Inclusion Criteria

- First stroke
- Within two years of diagnosis
- Mental score >7 / 10 (Hodgkinson, 1976)
- Star Cancellation Test 48 / 50
- Pain VAS < 7 / 10
- Speech deficits
  - Follow two-step command

UU VR Rehabilitation System

VR sessions

- Reach and retrieve tasks
  - Range of difficulty levels
  - Flexibility of object placement
  - Variety of object shape and size
  - Wrist extension task

User interacting with the VR system

'Whack the mouse' game

Clinical Profiles

- Patient A
- Male
- Age 76 years
- 3 years post stroke
- Independently mobile

- Patient B
- Female
- Age 60 years
- 4 years post stroke
- Independently mobile

Clinical Profiles

- Patient A
- L hemiplegia
- R hand dominant
- Nil of note on CT scan

- Patient B
- R cortical lesion
- L hemiplegia
- R hand dominant
- CT = basal ganglia haemorrhage

VR Training

- 3 sessions of 30-40 minutes
  - 3 X per week
  - Over 3 week period
- Physical outcome measures at pre and post training and at 6 weeks follow up.

Outcome Measures - User Experience

- Immersive Tendencies Questionnaire
  - Witmer & Singer (1998)
- Task Specific Feedback Questionnaire
  - Kizony et al (2003)
- Borg Scale of Perceived Exertion
  - Borg (1981)

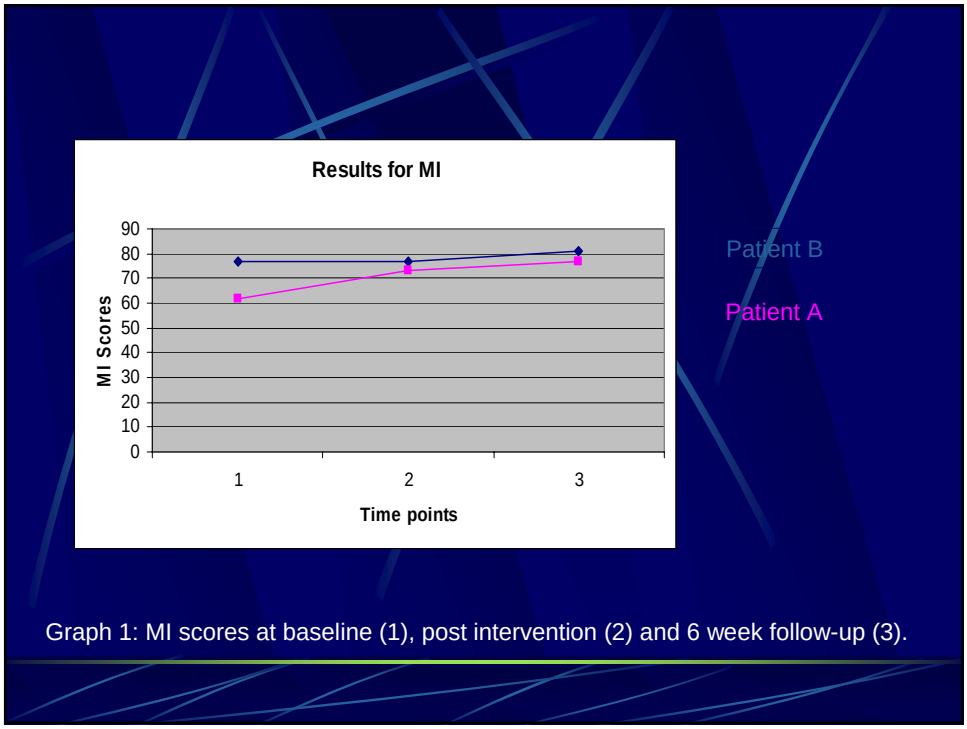
Outcome Measures - Motor Activity / Function

- Motricity Index (MI)
  - Measure of impairment
  - Arm section score out of 100. Grading of pinch, elbow flexion and shoulder abduction actions
- Action Research Arm Test (ARAT)
  - Measure of function
  - Score out of 60. Grading of grasp, grip, pinch and gross movement tasks

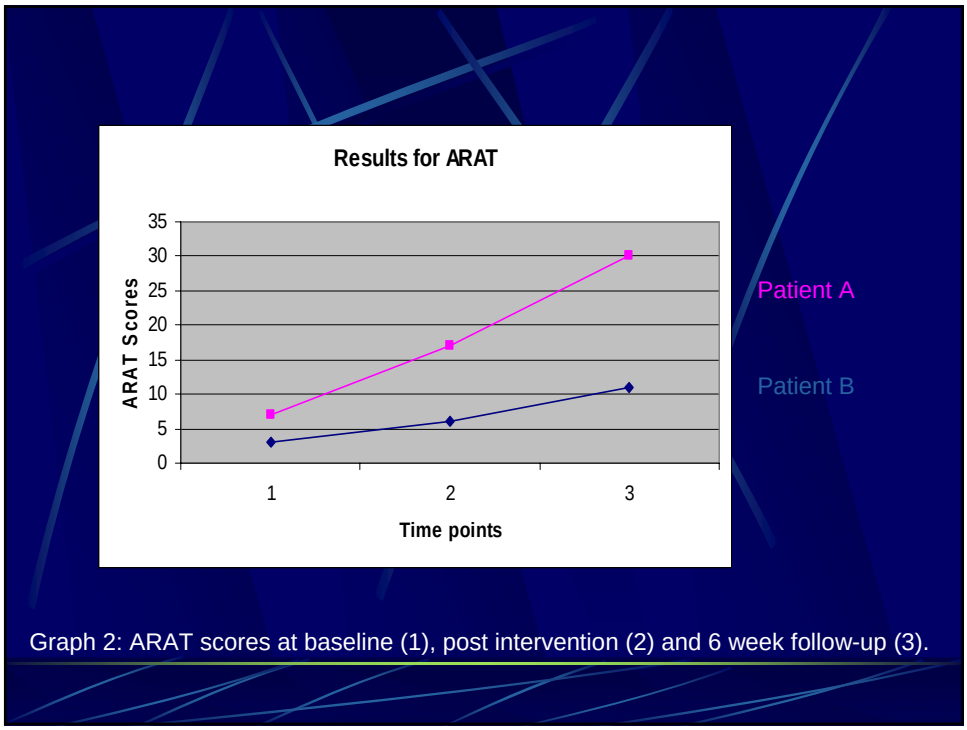
The same research therapist delivered the intervention and an independent therapist administered the outcome measures.

Results

- Improvements were found in the MI and ARAT scores following a three-week training period using a VR based exercise system for the upper limb.
- Both subjects self-reported that there was a change in day-to-day use of their upper limbs.



Graph 1: MI scores at baseline (1), post intervention (2) and 6 week follow-up (3).



Graph 2: ARAT scores at baseline (1), post intervention (2) and 6 week follow-up (3).

Level of impairment & function

- Often people after stroke improve in their impairment level but not in functional usage of their arm.
- The level of impairment or functional ability may affect the user experience of a VR rehabilitation system.

Level of impairment & function

- Patient A
- MI = 77 mild impairment
- ARAT = 3 limited function
- Borg = 2 / 10
- TSFQ=28 / 30

- Patient B
- MI = 62 moderate impairment
- ARAT = 4 limited function
- Borg = 10 / 10
- TSFQ = 28 / 30

Stroke User Comments

- ‘When I put that headset on it really makes me pay attention to my arm.’
- ‘I don’t usually bother with that arm but this made me think about using it.’
- ‘Using the VR system really has encouraged me to try to do more with my arm.’
- ‘I’ve been opening drawers in the kitchen that I didn’t know I could open with my bad hand.’

Conclusion

- Training with virtual reality can improve motor activity and function in the upper limb following stroke.
- Virtual reality would seem to have potential as a training device in stroke rehabilitation.
- Further study to explore any statistical relationship between level of impairment / function and user experience.

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