Motor-cognitive training through Immersive Virtual Reality (IVR) during the immobilization period in distal radius fracture patients: a randomized control trial study.

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Introduction

The immobilization period after a distal radius fracture lasts from 2 to 6 weeks, in which the patient suffers a loss of movement representation, joint stiffness and muscular atrophy[1]. In such cases, techniques such as Action Observation (AO) and/or Motor Imagery (MI), might prove useful to enhance the possibility of physical movement[2]. Moreover, recent evidence supports the use of Immersive Virtual Reality (IVR) as a means to apply visual feedback techniques in neurorehabilitation[3]. In this study we investigated the benefits of a self-developed IVR training program based on training for upper limb rehabilitation that aims to improve the motor functional ability of the arm and accelerate the rehabilitation process in patients with distal radius fracture.

Methods

We carried out a randomized control trial with 54 patients (mean±SD age= 61.80±14.18). Twenty patients were assigned to the experimental group (IVR), 20 patients to the Conventional Digit Mobilization (CDM) control group and 14 patients into a Non-Immersive (Non-IVR) control group. The IVR training consisted in visualizing virtual arm movements from first-person perspective. All measures were taken after the cast removal and 6 weeks later.

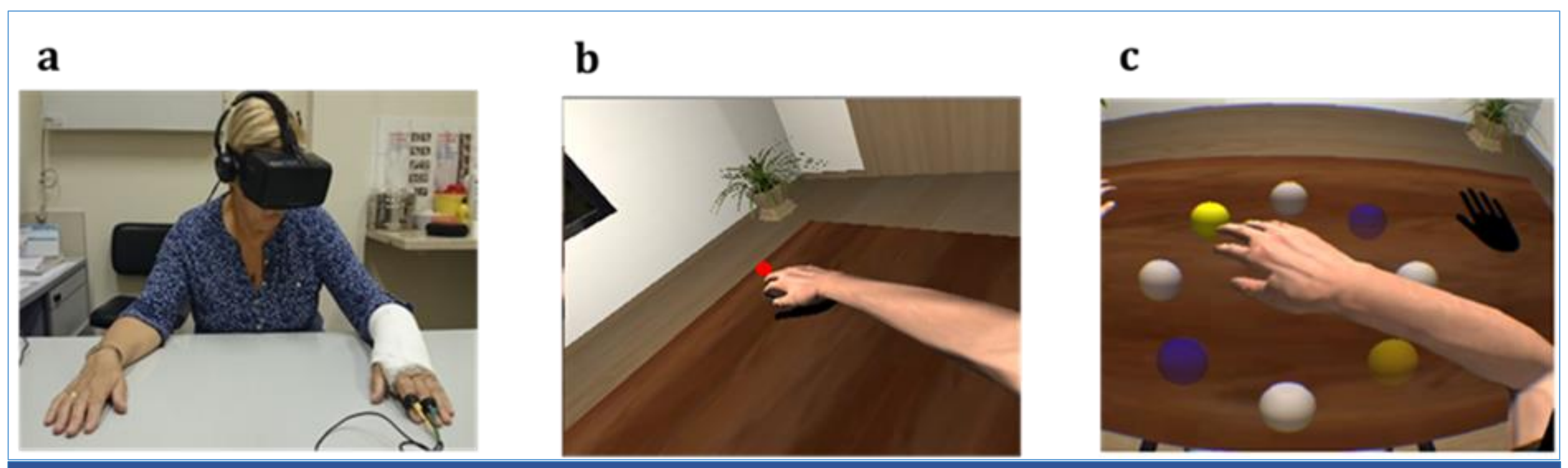


Figure 1. a) Patients position in the IVR group. b,c) They saw the visual feedback of the virtual arm movement.

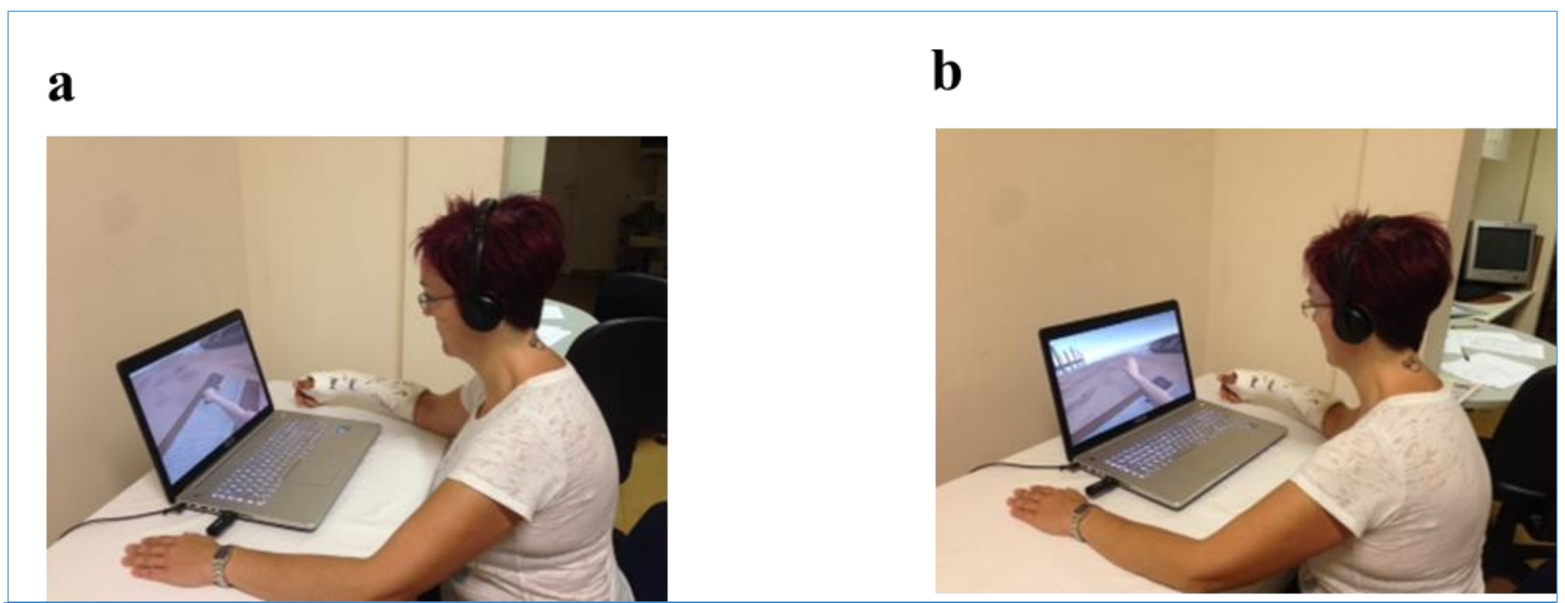
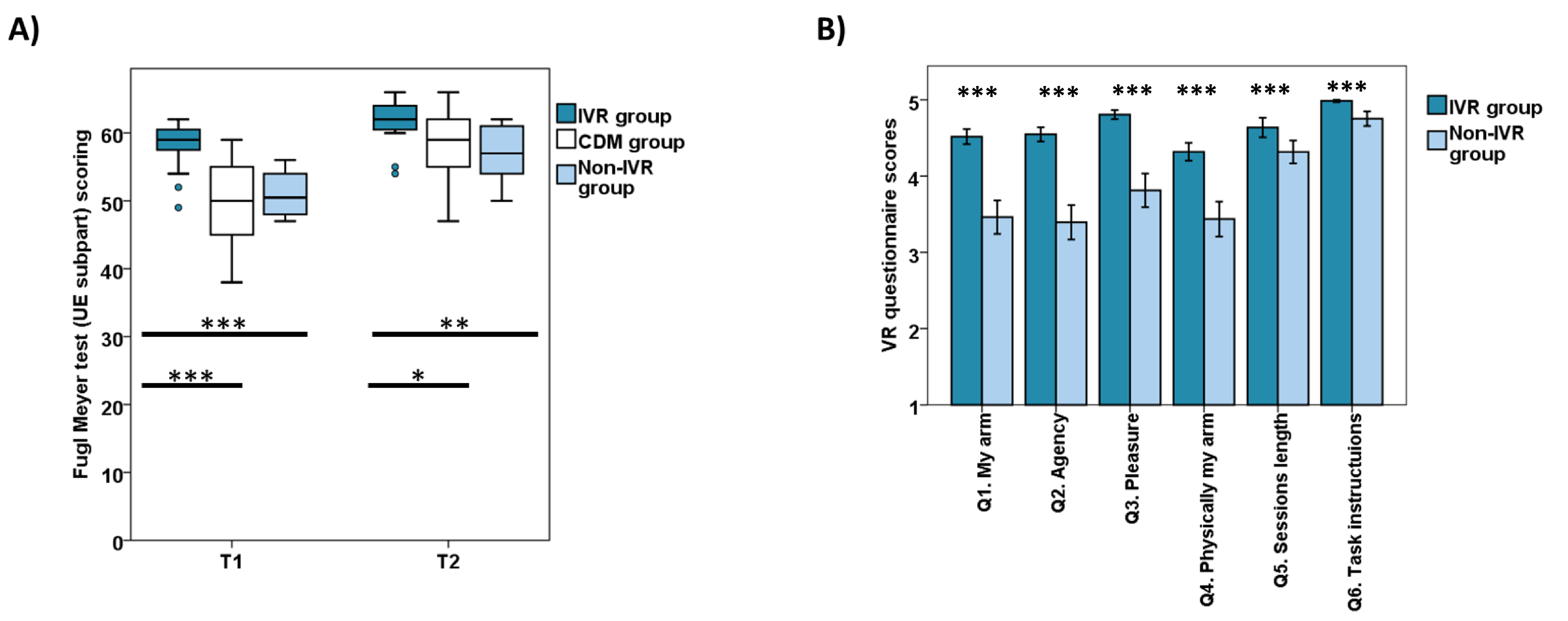


Figure 2. a) Patients position in the Non-IVR training. b) Patients saw the virtual arm movement.

Results

- We observed that a higher percentage of patients in the IVR training group presented better prognostic recovery of the functional ability of the fractured arm after cast removal and six weeks later compared with patients in the CDM and in the Non-IVR groups (one-way ANOVA, factor "group") **(Figure 1A).**
- Functional recovery of the arm in the IVR group was highly correlated with the scores on the IVR experience reported after each IVR session in the VR questionnaires **(Figure C).** Furthermore patients in the IVR group reported higher levels of body ownership **(Figure 1B).**
- Our data further showed improvements in the range of wrist flexion-extension and lower percentage of disability of the fractured arm compared to the Non-IVR and CDM groups after cast removal and 6 weeks later (one-way ANOVA, factor "group") **(Figure 2).**



C)

	Q1	Q2	Q3	Q4	Q5	Q6
Correlation coefficient	0.308 **	0.317 **	0.352 **	0.217 **	0.164	0.309 **
p values	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.01	P<0.0001

Figure 3. A) Functional ability recovery. **B)** Virtual reality questionnaire scores differences between IVR and Non-IVR groups. **C)** Relationship between the functional ability recovery of the arm after the cast removal (T1) with virtual reality questionnaire scores in IVR training

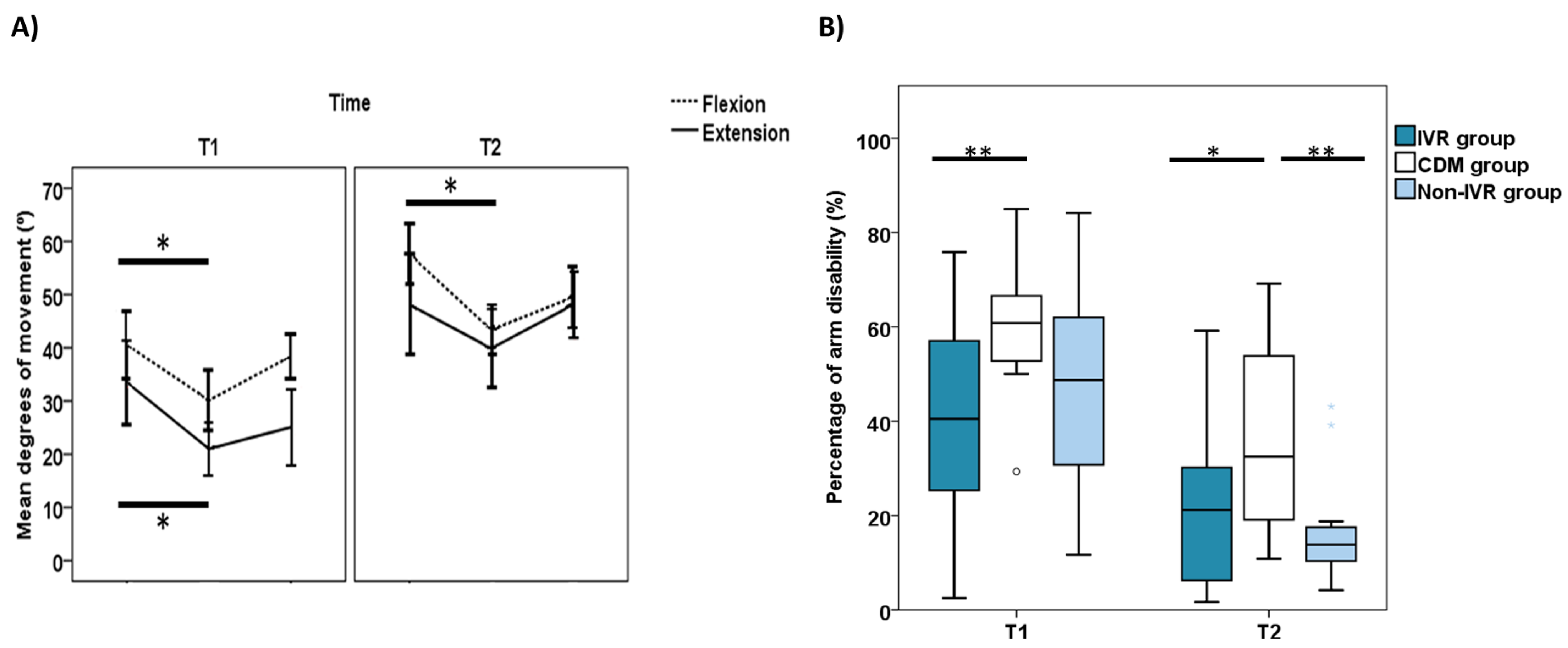


Figure 4. A) Wrist flexion-extension range of motion improvement. **B)** Percentage of disability decrease.

Conclusions

The results of this study suggest that feeling embodied in a virtual body through IVR can also be used as a rehabilitation tool to speed up and improve the motor functional recovery of the fractured arm after the immobilization period. Hence IVR can be also a promising tool to relearn motor skills in patients without movement due to other pathologies such as patients with neurological impairments.

Acknowledgements

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