Custom virtual reality system with real-time therapist interactions to enhance home exercise performance and adherence

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Background

- Virtual reality (VR) home exercise programs (HEP) are increasingly prescribed for patients post lower extremity (LE) joint replacements.
- One benefit of VR use is to promote HEP adherence.
- Exercise adherence and performance are typically enhanced by human interaction and real-time therapist feedback.
- These features are not commonly incorporated into commercially available VR systems.
- To address this, a custom VR system was developed using a Kinect2 sensor for motion tracking, avatar streaming, and live interactions.

Purpose

To evaluate use of a custom VR system on HEP performance in adults post LE joint replacement, and examine patient and therapist opinions of VR feedback features and potential to improve HEP adherence.

Methods

Demographics

Patient Participants
- n=13 (11F), 63.2 ± 7.7 years
- Unilateral joint replacement
- hip (n=5), knee (n=8)
- 3.1 ± 2.1 months post surgery

Therapist Participants
- n=11 (all female)
- 6 PT, 4 OT, 1 COTA
- Experience: 7.59 ± 6.8 years
- Observed VR session

Virtual System Design

- 25-joint motion tracking with Kinect2 sensor
- Low-bandwidth streaming of motion data
- Virtual system accessed via web browser
- Allows multiple users to participate
- Audio for easy communication

Data Collection

Patient Participants
- completed 2 LE exercise sessions in random order
- (Exercises: hip abduction, extension, flexion, and squats)

1 Live VR Session
- Online **virtual system**
- Therapist guided
- Verbal Feedback
- Graphical Feedback
- LE 3D Motion Recorded

2 Conventional HEP Session
- **Written HEP** Only
- Independent Exercising
- LE 3-D Motion Recorded

Therapist Participants
- Observed a VR session in the therapist room
- Provided opinions of system from therapist perspective

Data Analysis

Exercise Performance | Effect of feedback on performance

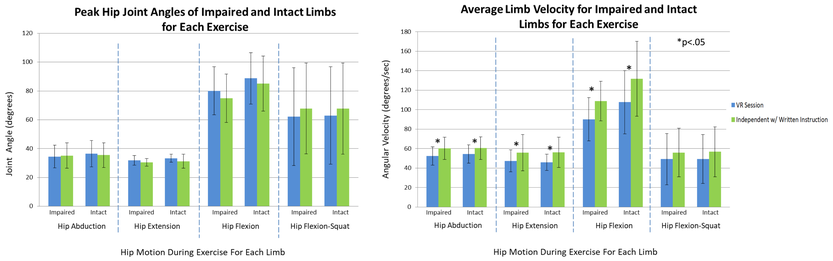
Compared key measures between exercise conditions:
- Peak hip joint angles during exercise
- Movement velocity of exercising limb
- Peak joint angles of compensatory movements

Patient/Therapist preferences of VR system
- Standardized questionnaire completed by all
- Examined opinions of system features/ effect on adherence
- Likert Scale responses converted into percentages
- Open-ended responses grouped to find common remarks

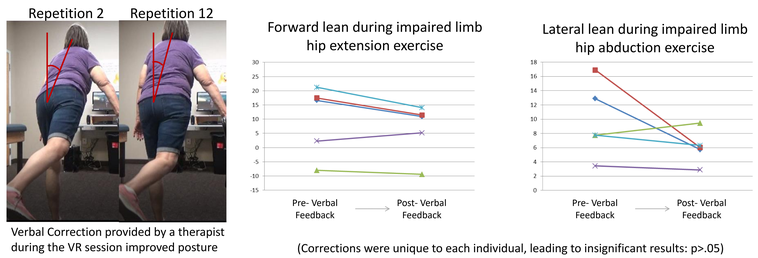
Results – Comparing VR Session to Conventional HEP Session

Patient Performance

Similar Exercise Performance in Both Conditions, but Faster During Conventional HEP Session



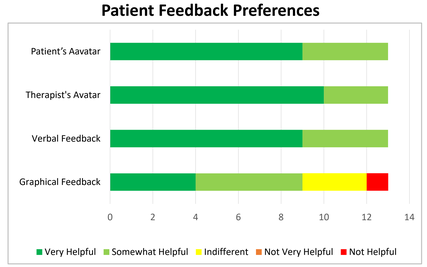
Use of Verbal Feedback Promoted Correction of Compensatory Movements

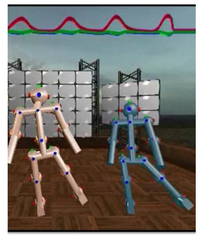


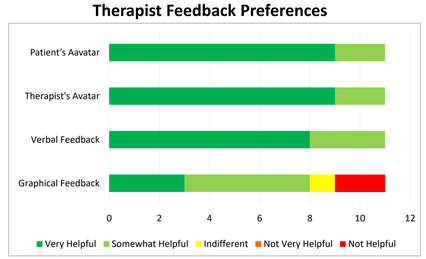
Verbal Correction provided by a therapist during the VR session improved posture

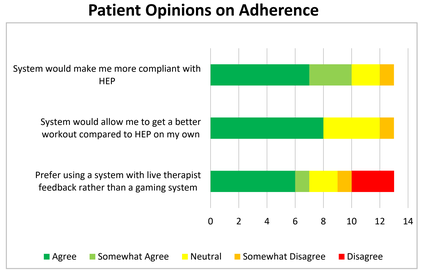
(Corrections were unique to each individual, leading to insignificant results: p>.05)

Patient/Therapist System Feedback Preferences and Effect on Adherence

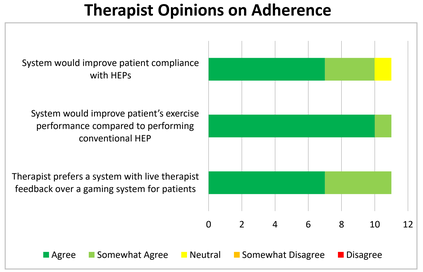








Participants felt a live interaction with visual/verbal feedback would be *helpful* and likely improve *adherence*



Discussion

- **Patients and observing therapists valued the interactive experience combining immediate visual and verbal feedback.**
- **Remote therapist interactions afforded real-time feedback that encouraged postural corrections and influenced movement speed.**
- **VR systems should consider the role of real-time therapist interactions to promote engagement and HEP adherence.**

References

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Acknowledgements

This work was supported by the University of Florida Institute of Informatics Seed Fund