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Pilot Study on the Clinical Feasibility of Using Immersive Virtual Reality for Robot-assisted Gait Training in Patients with Neurological Diseases

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Introduction

Neurological diseases can disrupt motor functions leading to a range of gait impairments including reduced speed altered stride length and impaired balance. For instance stroke can cause hemiplegia significantly affecting the affected limb's functionality. Similarly individuals with Parkinson's disease often experience freezing of gait contributing to falls and reduced mobility. Robot-assisted gait training has gained traction in rehabilitation settings due to its potential to provide consistent high-intensity training. Robotic exoskeletons and treadmills with robotic support can facilitate gait training by assisting patients in performing walking movements while ensuring safety. These systems can adjust support based on real-time feedback promoting adaptive learning and encouraging neural plasticity. IVR involves creating a computer-generated environment that immerses users in a virtual world. By engaging multiple sensory modalities IVR can enhance motivation enjoyment and cognitive engagement during rehabilitation. Studies have shown that IVR can improve motor function cognitive abilities and overall rehabilitation outcomes in various populations including individuals with neurological disorders [1].

Integrating IVR with robot-assisted gait training offers the potential for a more engaging and effective rehabilitation experience. IVR can create motivating scenarios that simulate real-world environments while robotic systems can provide the necessary physical support. This combination may enhance patients' adherence to rehabilitation programs and improve overall functional outcomes. Descriptive statistics will be used to summarize participant characteristics and outcome measures. Pre- and post-intervention comparisons will be performed using paired t-tests or Wilcoxon signed-rank tests depending on data distribution. A significance level of $p<0.05$ will be considered statistically significant. We anticipate recruiting 20 participants over a 3-month period. Baseline characteristics will be summarized including demographics type of neurological disease and baseline functional status [2].

Description

Preliminary findings regarding the safety and tolerability of the intervention will be reported including any adverse events or complications. Participant feedback on the feasibility of using IVR in combination with robotic assistance will be gathered through interviews or questionnaires. Changes in gait parameters (speed, stride length, cadence) and functional mobility (TUG scores) will be analysed to assess the effectiveness of the intervention. Effect sizes will be calculated to determine clinical significance. The integration of IVR with robot-assisted gait training has the potential to transform rehabilitation practices for patients with neurological diseases. By enhancing engagement and motivation this combined approach may lead to improved outcomes and better adherence to rehabilitation programs. Research staff including physical therapists and rehabilitation specialists will receive training on the use of the robotic exoskeleton and IVR system. Training will include understanding the technology managing safety concerns and fostering an engaging therapeutic environment. Staff will also be instructed on monitoring participant responses during sessions to ensure safety and optimize the training experience [3].

The 10-meter walk test will measure gait speed and stride length. Participants will be timed while walking a straight line with measurements taken at both baseline and post-intervention to evaluate changes in performance. The TUG test will assess functional mobility. Participants will be timed as they rise from a chair walk three meters turn around walk back and sit down. Improvements in TUG times will indicate enhanced mobility and balance. After completing the intervention participants will complete a questionnaire assessing their satisfaction with the training. Questions will focus on the perceived effectiveness enjoyment of the VR experience and overall experience with robot-assisted training.

Participants will be recruited through the neurology outpatient clinic with flyers and informational sessions aimed at educating potential participants about the study. Research staff will conduct initial screenings to assess eligibility based on inclusion and exclusion criteria. Interested individuals will be invited to participate in an informed consent process ensuring they understand the study's purpose procedures risks and benefits. The intervention will be structured to maximize engagement and ensure a comprehensive rehabilitation experience. Each session will incorporate the following elements. The warm-up phase will include guided stretching and range-of-motion exercises tailored to individual capabilities. This phase will be essential in preparing participants for the more intensive robot-assisted training. Participants will be fitted with a robotic exoskeleton designed to assist in walking. The exoskeleton will provide adjustable support based on real-time feedback from sensors that monitor gait mechanics [4]. This allows for individualized adjustments to the level of assistance promoting an adaptive learning environment. During training therapists will provide guidance ensuring proper posture and technique. The IVR component will feature various scenarios designed to simulate real-life walking challenges such as navigating obstacles walking on different terrains and engaging with virtual characters. This element aims to enhance cognitive engagement and motivation addressing both physical and psychological aspects of rehabilitation [5].

Conclusion

In conclusion, this pilot study seeks to evaluate the clinical feasibility of using immersive virtual reality in combination with robot-assisted gait training for patients with neurological diseases. By leveraging technological advancements the study aims to contribute to the evolving landscape of neurorehabilitation offering hope for improved mobility and quality of life for

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individuals facing the challenges of neurological impairments. The findings will not only inform clinical practice but also pave the way for future innovations in rehabilitation strategies. Future research should focus on larger randomized controlled trials to validate the findings of this pilot study. Long-term follow-up assessments are also essential to understand the sustained effects of the intervention on gait and functional mobility. Further exploration of the optimal design of IVR scenarios tailored to individual patient needs may enhance therapeutic outcomes.

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Conflict of Interest

None.

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