An Adjunct Virtual Reality Protocol for Rotator Cuff Rehabilitation

Yvon M. Bogdonoff[1], Farid Amirouche[1, 2]
[1]Department of Orthopaedic Surgery, University of Illinois College of Medicine at Chicago, Chicago, IL, 60612, USA.
[2]Orthopaedic and Spine Institute, NorthShore University Health System, Chicago, IL, 60611, USA.
Email of presenter: ybogdo2@uic.edu

Disclosures: Yvon M. Bogdonoff (None), Farid Amirouche (None)

INTRODUCTION: Following injury to the rotator cuff, a traditional physical therapy regimen is often prescribed. Timelines of the progression of the physical therapy range with severity. Therapy is typically broken into seven phases for tears smaller than three centimeters. A model physical therapy program provided by Massachusetts General Hospital is referenced herein[1]. Virtual reality (VR) systems have been identified as a possible adjunct for rehabilitation therapy in numerous contexts. Their ability to be married with motion sensors to capture accurate, real-time information about the patient in the privacy of their homes lends these systems well to monitor rehabilitation progress[2]. Virtual reality systems have already been explored in rural areas to assist stroke patients with shoulder pain[3]. VR systems have the advantage of portability, low cost, accessibility, and adaptability that make the systems tunable to the patient's needs. This study seeks to answer what an optimal virtual reality protocol looks like for rotator cuff rehabilitation. We hypothesize that our protocol will deliver point-of-care rehabilitation engagingly and quantitatively that can be used as a supplement to a traditional physical therapy protocol.

METHODS: Seven healthy volunteers were recruited to participate in a rehabilitation protocol proof of concept and validate data collection. Data collection occurred at the University of Illinois College of Medicine, Chicago campus. Three workouts were performed by each participant, designed to serve as an adjunct to phases two, three, and four of the exemplary Massachusetts General Hospital protocol. Phase two consists of a five-minute forward shoulder flexion exercise regimen up to 90 degrees. Phase three consists of a ten-minute exercise regimen of forward shoulder flexion up to 120 degrees, 30 degrees of external rotation, and 30 degrees of internal rotation. Phase four consists of a fifteen-minute exercise regimen of forward shoulder flexion up to 120 degrees, 45 degrees of internal rotation, 45 degrees of external rotation, and 90 degrees of shoulder abduction. As seen below, games were designed to limit the participant's range of motion to the prescribed ranges of the exemplary Massachusetts General Hospital protocol.

RESULTS SECTION: Representative schematics of phases two, three, and four demonstrate the system's ability to measure and score different active ranges of motion. High scores, trends between active players, and individual game settings are also provided. The rehab system was effective in measuring single-joint shoulder flexion and abduction, as well as proxies for internal rotation and external rotation. All seven participants completed 30 minutes of workouts in total in one session.

DISCUSSION: Data collection of various shoulder movements using the rehab system was robust and easily attainable. The quantifiable metrics of game scoring trends, range of motion tolerance, and exercise adherence are valuable tools that can help healthcare providers gauge a patient's recovery status. Current limitations of the software include a need for more specific single joint movements, particularly internal rotation and external rotation exercises. Further restrictions include the use of only healthy subjects. With additional iterations of the software, this protocol can be scaled to the patient's needs. In conclusion, this study presents a compelling framework for an adjunct VR rehabilitation protocol that aligns with established traditional physical therapy phases. The results highlight the potential benefits of VR systems for enhancing recovery outcomes in rotator cuff injuries. Further research and development efforts are warranted to refine the protocol, address limitations, and ensure the integration of VR rehabilitation into the broader spectrum of healthcare.

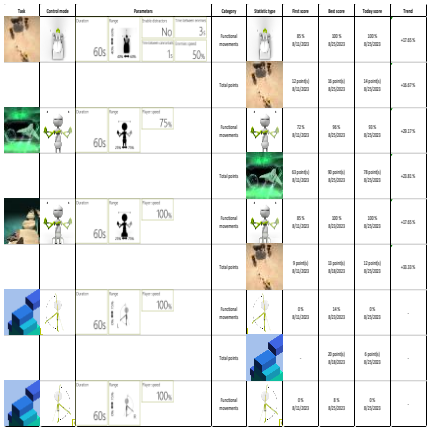
SIGNIFICANCE/CLINICAL RELEVANCE: This study provides a representative framework for a VR rehabilitation regimen aligned with a traditional physical therapy protocol. Successful iteration and optimization of virtual reality rehabilitation protocols may increase accessibility to rehabilitation care, lower healthcare system costs, and improve recovery outcomes.

REFERENCES:
1. "Rehabilitation Protocol for Rotator Cuff Repair-Small to Medium Sized Tears" Massachusetts General Hospital, The General Hospital Corporation, https://www.massgeneral.org/assets/mgh/pdf/orthopaedics/sports-medicine/physicaltherapy/rehabilitation-protocol-for-rotator-cuff-repair.pdf
2. Alejandro Baldominos, Yago Saez, Cristina García del Pozo, An Approach to Physical Rehabilitation Using State-of-the-art Virtual Reality and Motion Tracking Technologies, Procedia Computer Science, Volume 64, 2015, Pages 10-16, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2015.08.457. (https://www.sciencedirect.com/science/article/pii/S1877050915025922)
3. Funao H, Tsujikawa M, Momosaki R, Shimaoka M. Virtual reality applied to home-visit rehabilitation for hemiplegic shoulder pain in a stroke patient: a case report. J Rural Med. 2021;16(3):174-178. doi:10.2185/jrm.2021-003

IMAGES AND TABLES:

Phase 2 Therapy Regimen

Phase 3 Therapy Regimen



Phase 4 Therapy Regimen