

# Application of Virtual Reality in Orthopaedic Conditions

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**Abstract:** In this paper a brief review of virtual reality application in orthopaedic treatment is presented. The use of virtual reality to treat patients with orthopaedic disorders has been discussed. Virtual reality is an interactive technology that enables for personalised treatment and could aid in the delivery of effective person-centered rehabilitation. In orthopaedics, virtual reality exergaming treatment has been shown to have a significant impact on pain reduction and enhanced joint mobility.

**Keywords:** Exergaming, Kinematic Training (KT), Knee osteoarthritis, Orthopaedic treatment, Shoulder pain, Virtual reality.

## I. INTRODUCTION

Virtual reality (VR), in which participants interact with a computer by moving their bodies, is a new type of treatment in rehabilitation settings. With the help of artificial intelligence technology VR produces an artificial environment in the space for the participants. It uses different kinds of sensor devices and computer software to give feeling of artificial environment to the subject. There are three components of virtual reality: Interaction, immersion, and imagination. These are all important components of the learning process [1]. Many medical and rehabilitation areas have turned to virtual reality as a therapeutic technique. VR technology has become a useful tool and a popular trend in a variety of industries because of its low cost and ease of use.

The major bottlenecks for VR use in rehabilitation are trained technician, motivated patients and skilled physiotherapist. The motivation and attitude of the therapist are often important factors in the clinical usage of VR [2-3]. The majority of VR's clinical applications are for neurological issues. Furthermore, multiple studies suggest that VR is utilised to treat individuals with stroke, cerebral palsy, Parkinson's disease, and other neurological disorders [4-9].

## II. VIRTUAL REALITY

Two types of virtual reality technology are used (a) non-immersive virtual reality and (b) immersive virtual reality for

treatment. The user can watch and interact with a computer-generated representation of themselves on a screen using a mouse or various hand-held devices in non-immersive VR. In this situation, the user may see and experience the real world outside of the screen, therefore he or she is not entirely submerged in a virtual environment. Nintendo Wii™ and Microsoft Kinect™ are examples of non-immersive VR devices.

Immersive VR allows for somatosensory manipulation, which could open up new possibilities for assessing and managing persons with musculoskeletal disorders. Because of the engaging environment, VR-based rehabilitation encourages patients to stay participating, resulting in increased commitment and improved performance. Previous studies on the effects of VR have been conducted in individuals with non-specific chronic neck pain, subacromial impingement syndrome, after knee surgery, and in neurological illnesses. Discomfort and physical weakness are more common in musculoskeletal diseases, resulting in 54% long-term disability and 24% impairment of daily life and routine exercise routines. Because of the increased usage of VR-based therapy as a motivational rehabilitation mechanism in patients with musculoskeletal disorders, and have to decide how to employ it as a motivational rehabilitation mechanism. Virtual reality is largely used in neurological illnesses such head trauma, stroke, autism, cerebral palsy, and cognition rehabilitation, with only a few research on musculoskeletal conditions. VR's usage in the treatment of musculoskeletal problems is still in its early stages, and more study is needed to prove its practicality and utility in this discipline.

## III. REVIEW METHODOLOGY

Different "keywords" and "Boolean Operators" were used to search databases such as PubMed, CINAHL, REHABDATA, etc. Only those research papers were considered in the investigation which has reported VR use in orthopaedic rehabilitation. Research reports only written in English were included in the review process. Different parameters such as range of motion, pains etc. were considered for assessment. Reports which included subjects with neurological disorder or

other chronic illness were not considered for the investigation. Reviews and conference proceedings were also excluded.

#### IV. APPLICATIONS OF VR IN ORTHOPAEDICS CONDITIONS

##### A. Shoulder Pain

Pekyavas [10] did a study to see how beneficial combined home-based exercises and VR exergaming are for people with subacromial impingement syndrome. Thirty participants with scapular dyskinesia and subacromial impingement syndrome were separated into two groups: VR exergaming (n = 15) and home-based exercise (n = 15). Participants were treated for 6 weeks, 45 minutes per session and 2 days per week. They assessed participants of both the groups with Neer test and Scapular dyskinesia. It is found that VR exergaming showed better results in improving pain at night.

Donny *et al.* [11] did another study on a randomised analysis of frozen shoulder patients who met the inclusion criteria. The sample was randomised and divided into 2 groups. Group 1 (control) received ultrasound diathermy in the shoulder area for 10 minutes and stretching exercises with an overhead pulley (OHP) 3-9 times per week, while Group 2 (treatment) received ultrasound diathermy in the shoulder area for 10 minutes and stretching exercises with virtual reality games (VRG) 3-9 times per week. They came to the conclusion that stretching with VRG is a new therapeutic option for people who could have a frozen shoulder ache.

##### B. Neck Pain

Bahat *et al.* [12] investigated the efficacy of KT with and without VR in those subjects suffering from severe neck discomfort. A total of 32 people with chronic neck discomfort were split into two groups: (n = 16) KTVR and only KT (n = 16), 5-6 weeks of supervised VR or KT, 30 minutes each session, in 4-6 sessions for 18 weeks, 3 days per week, both groups received home-based KT. They found that the KTVR group had much better flexion range and global perceived effect, while the KT group had significantly better rotation range and velocity.

David *et al.* [13] conducted a study with 44 subjects with severe neck agony who were divided into two groups. Group 1 got VR treatment, which included the use of VR vox play glasses and a clamping device coupled to a smartphone (LG Q6) attached clamping device. For VR two programmes have been installed. The 'Fulldiver VR' category was used for participants with the first degree of difficulty, while 'VR ocean aquarium 3D' was used for those with the second degree of difficulty. Group 2 received neck exercises, which consisted of three series of ten repetitions of each exercise with 30 seconds of rest in between. 3 sets of 10 repetitions of each exercise, with a 30 second break in between. The intervention lasted four weeks and eight sessions, with two therapy sessions per week. The outcome

variables were measured at the start of the study, one month later, and three months later, as well as after the intervention. They came to the conclusion that interactive VR is a useful strategy for lowering NS-CNP kinesiophobia.

##### C. Knee Pain

Kim *et al.* [14] investigated the results of a horseback-riding simulator and strengthening exercises on different parameters in old age persons with knee disorder. A total of 30 senior people with knee OA were divided into two groups: Strengthening exercises (n = 15) and a horseback riding simulator (n = 15). The total study was done for 8 weeks, with 30 minutes per session and 3 days per week. They concluded that VR group demonstrated significant improvements in pain, pain pressure threshold (PPT), function, and fear avoidance effect.

Lin *et al.* [15] compared VR exergaming to closed kinetic exercises in those with knee OA. In [15] a total of 89 people with OA were separated into three groups: computerized proprioception facilitation exercise (CPFE) (n = 30) and closed kinetic chain exercise (CKCE) (n = 29) are proprioceptive exergaming exercises. Control group (n = 30): no treatment 8 weeks, 40 minutes per session, 3 days per week. In comparison to the no-treatment control group, patients in the CPFE and CKCE groups had better knee joint position sense, function, mobility speed, and muscle torque. The position sense, function, and mobility speed of patients in the CPFE and CKCE groups were almost similar.

##### D. Low Back Pain

Park *et al.* [16] conducted a study on patients with chronic work-related low back pain, compare the effects of Nintendo Wii Fit and lumbar stabilisation exercises. A total of 24 people with chronic low back pain were separated into 3 groups: (n = 8) VR (n = 8) VR (Stabilization of the lower back (n = 8) Control group with no activity (n = 8). All subjects were also given hot packs, interferential, and ultrasound treatments. 8 weeks, 30 minutes per session, 3 days a week. They came to the conclusion that no comparisons were made between groups. Pain levels were significantly reduced in the VR and lumbar stabilisation groups. Balance was significantly improved in both the control and lumbar stabilisation groups. In the mental health sector, the VR group showed a considerable improvement. Back strength and physical health improved significantly in all three groups.

Thomas *et al.* [17] investigated the possibility of a computer simulated dodgeball involvement for the treatment of severe low back pain (LBP) patients. A total of 53 people with persistent LBP were separated into two groups: (n = 27) VR Control group (n = 26): no treatment 3 days in a row, 15 minutes per session on average, 1 time per day they came to the conclusion that the two groups did not differ significantly in all measured variables.

## V. DISCUSSION

Only a few studies related to VR application on various musculoskeletal diseases have been reported in the literature. One investigation reported better efficacy of virtual reality compared to exercises in the treatment of shoulder pain. Here, a controlled virtual reality was compared with an uncontrolled home programme [10]. Two investigations on knee pain reported comparison between the treatment using virtual reality and exercises [14-15]. Another study done by Thomas *et al.* [17] revealed the drawbacks of virtual reality application on LBP treatment. However, the treatment period of only 3 days in this moderate-quality trial is insufficient to draw any conclusions.

In [16] the investigation reported that the back pain was significantly reduced in the virtual reality and exercise control groups compared to no-treatment group. Surprisingly, neither the VR nor the other two groups improved their balance. However, because these findings were based on within-group differences rather than between-group comparisons, no conclusions about VR's effectiveness can be reached when compared to the other therapy alternatives investigated. To establish practicality and utility of VR in the orthopaedic treatment, more research is required.

## VI. CONCLUSIONS

All studies reported the effectiveness of VRG on orthopaedics limitations. In musculoskeletal problems, VR treatment revealed significant improvements in pain, function, and quality of life, as well as enhanced joint mobility and reduced fear of pain. However, because there is currently inadequate evidence in the literature, more research is needed to investigate the therapeutic effects of VR treatment on musculoskeletal disorders.

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