ORIGINAL ARTICLE

Effects of virtual reality exercises and routine physical therapy on pain intensity and functional disability in patients with chronic low back pain

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Abstract

Objective: To compare the effects of Virtual Reality exercises and routine physical therapy on pain and functional disability in patients with chronic low-back pain.

Methods: The single-blind randomised controlled trial was conducted from April to October 2020 at the Physiotherapy Department of the Government Services Hospital, Lahore, Pakistan, and comprised patients of either gender, aged 25-50 years with chronic non-radiating low-back pain who were randomised into two equal groups. Group A received routine physical therapy, while group B received Virtual Reality exercises with routine physical therapy. Visual Analogue Scale and Modified Oswestry Disability Index were used to measure outcomes at baseline and after 4th, 8th and 12th sessions. Data was analysed using SPSS 24.

Results: Of the 84 patients, there were 42(50%) in each of the two groups. There were 28((33%) males and 56(66.6%) females. The mean age in group A was 37.5±12.5 years and in group B it was 38.2±11.8 years. Pain score at baseline was 6.62±1.04 in group A and 6.50±1.24 in group B which decreased to 3.32±0.81 and 1.00±0.60 respectively after the 12th session (*p*<0.05). Functional disability score at baseline was 65.08+8.94 in group A and 69.16±9.13 in Group B which decreased to 40.56±8.59 and 16.04±6.82 respectively after the 12th session (*p*<0.05). Group B showed significantly better results than group A (*p*<0.05).

Conclusion: Virtual Reality exercises in combination with routine physical therapy had dominant effect on functional disability and low-back pain.

Trial Registration Number (IRCTID): IRCT20200330046895N1

Keywords: Chronic low back pain, Virtual reality exercise, Modified Oswestry disability index, Pain intensity.

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Introduction

Chronic low-back pain (CLBP) is commonly known as "chronic pain in the lower back area" potentially inhibiting the ability of the afflicted individual in performing the normal activities of daily living (ADLs). CLBP is often categorised as acute, sub-acute, or chronic depending on the duration of the current episode.[1,2] CLBP persists for >12 weeks.[3] Prevalence of LBP is reported from 51% to 84% and high frequency is seen in low- and middle-income countries (LMICs) though it is a common ailment that causes disability worldwide.[4] As the population ages over the coming decades, the number of individuals with LBP is likely to increase substantially.[5] Among all chronic pains and spinal pain conditions, LBP is the leading cause of activity limitation and work absence around the globe.[5] There is a lack of consensus evidence for the indication and effectiveness of spinal surgeries and interventions.[6] It can be influenced by a wide range of other factors, including cognitive component, poor motivation, catastrophic thoughts and beliefs are seen to act as catalysts for chronicity, contributing to the low recovery and prolonged disability rates.[7] Psychological therapies for chronic pain differ in their scope, duration and goals, showing distinct patterns of treatment efficacy. The fear-avoidance model for CLBP posits a generic movement restriction that can be thought to be threatening, and it is evident that individuals with high fear with CLBP specifically avoid flexion of the lumbar spine.[8] Patients, after medical care, return to work and improve rapidly in the first month. However, up to one-third of patients report persistent back pain of at least moderate intensity one year after an acute episode, and 1 in 5 report substantial limitations in activity. There are multiple treatment options for CLBP, including pharmacological and surgical treatment, but, initially, it is recommended to use multidisciplinary approach with exercise ,stress reduction, relaxation therapy and spinal manipulation and electrical stimulations like low laser and biofeedback with electromyography[3,9] and instrument-assisted soft tissue mobilisation which is a modern form of myofascial release as well.[10] The core-stability and Swiss ball-based exercises were also considered equally effective,

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but limited to post-partum pain.[11] Postural correction with the use of sustained natural apophyseal glides is considered effective in cases of mechanical nature of pain as well.[12] There is evidence of short-term efficacy (moderate for pain and small for function) of opioids to treat CLBP compared with placebo. The effectiveness and safety of long-term opioid therapy for the treatment of CLBP remains unproven.[13]

Several studies have proven the effectiveness of Virtual Reality (VR) in a variety of medical, psychological and physiotherapy conditions, including a variety of neurological and musculoskeletal disorders, to improve balance, coordination, acute and chronic pain. VR exercises (VREs)can be used to manage LBP, functional activities and motivation, to reduce the loss of working days and to achieve optimal physical rehabilitation.

The current study was planned to find out the effectiveness of two interventional strategies, including routine physical therapy (RPT) and VREs, on intensity of pain and functional disability among patients having CLBP.

Patients and Methods

The single-blind randomised controlled trial (RCT) was conducted from April to October 2020 at the Physiotherapy Department of the Government Services Hospital, Lahore, Pakistan. After approval from the institutional ethics review committee, the sample size was calculated using the formula N= (Z 2α+Z2 β)2*S)2/Δ2[14] while keeping mean pain in the experimental group 2.52±1.80 and mean pain in control group 4.90±3.39, confidence interval (CI) 0.95 and power of test 0.8.[15] The study was conducted using the Consolidated Standards of Reporting Trials (CONSORT) pattern.[16]

The sample was raised using purposive sampling technique. Those included were patients of either gender aged 25-50 years with CLBP history. Patients with congenital deformity, history of trauma, fracture of the spine or the lower extremity, any systematic disease or neurological diseases, those on corticosteroid and pregnant females were excluded.[17,18]

After taking informed consent from the subjects, they were randomised into RPT group A and VRE group B using the coin toss method. Visual Analogue Scale (VAS) was used for pain assessment as 0-4 mild pain, 4-7 moderate or distressing pain and 7-10 unbearable pain or worst pain.[19] The Modified Oswestry Disability Index (MODI) was used to measure low-back functional disability.[20]

Both the outcomes were measured by the assessor, who was blinded to the randomisation. Group-A was given RPT with 10 minutes of heat therapy by a moist hot pack, and hamstring stretching. Back strengthening exercises included 10 repetition of bridging, prone leg raises, trunk extension in prone with arms behind the back, trunk rotation exercises, knee to chest, and prone position with a diagonal elevation of the arm and the leg.[21]

The experimental group B was exposed to VREs using kinetic exergames, like the body ball game and reflex ridge, with on-screen display for 5 minutes each, along with RPT. Non-immersive system with a kinetic device (Model V.2) was used which is a motion-sensing input device incorporated with red-green-blue (RGB) cameras and time-of-flight (TOF) sensor with real-time gesture recognition and body skeletal detection. It was attached with the liquid crystal display (LCD) screen. In the VRE group, the patients were subjected to trunk slide flexion, sitting to avoid obstacles, jumping and combined movement of arms for 5 minutes, as displayed on the mounted LCD. After 30 seconds of rest, the body ball game, including moving arm, head pushing and kicking of ball, for 5 minutes was introduced. Both the groups received sessions on alternative days, with 3 sessions per week for a total of 12 sessions. The outcomes were measured at the baseline, and after the 4th, 8th and 12th sessions.

Data was analysed using SPSS 24. For quantitative variables, like age, pain and disability, mean and standard deviations were calculated, and for qualitative variables, like gender, occupation, functional status, frequencies and percentages were calculated. After checking the normality of the data, repeated measure analysis of variance (ANOVA) was used for variables of interest for intra-group comprisons, while independent test was used for inter-group comparisons. P<0.05 was considered significant.

Results

Of the 84 patients, there were 42(50%) in each of the two groups (Figure). There were 28(33%) males and 56(66.6%) females. The mean age in group A was 37.5±12.5 years and in group B it was 38.2±11.8 years (Table 1).

Pain score at baseline was 6.62±1.04 in group A and 6.50±1.24 in group B which decreased to 3.32±0.81 and 1.00±0.60 respectively after the 12th session ($p<0.05$). Functional disability score at baseline was 65.08±8.94 in group A and 69.16±9.13 in Group B which decreased to 40.56±8.59 and 16.04±6.82 respectively after the 12th session ($p<0.05$) (Table 2).

While both groups showed significant intra-group differences post-intervention, group B registered significantly better results than group A ($p<0.05$) (Table 3).

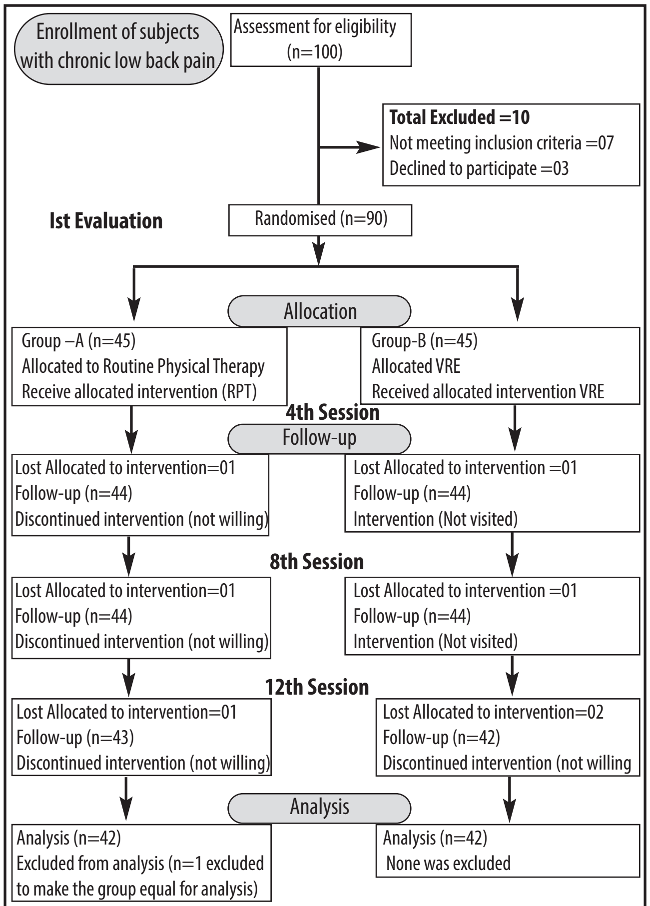

Figure: Consolidated Standards of Reporting Trials (CONSORT).

Table-1: Demographic data.

Variables	**Group A** (n=42) n (%)	**Group B** (n=42) n (%)	**Total** (n=84) n (%)
Gender			
Males	15(35.7)	13(30.95)	28 (33.3)
Females	27(64.28)	29(69.04)	56(66.6)
Body Mass Index			
Underweight	08(19)	11((26.19)	19(22.61)
Normal	24(57.14)	26(61.90)	50(59.52)
Overweight	10(23.8)	5(11.90)	15(17.85)
Occupation			
Housewives	10(23.8)	11((26.19)	21(25)
Teacher	4(9.52)	33(7.14)	07(8.33)
Bankers	4(9.52)	5(11.90)	09(10.7)
Office worker	7(16.66)	5(11.90)	12(14.28)
Health care Professional	3(7.14)	4(9.52)	07(8.33)
Farmer	5(11.9)	4(9.52)	09(10.71)
Others	09(21.42)	10(23.8)	19(22.61)
Functional Status			
Daily Activities	25(59.52)	19 (45.23)	44(52.38)
Regular Exercise Routine	17(40.47)	23(54.76)	40(47.61)
Daily Activity Level			
Sedentary	10(23.8)	11((26.19)	19(22.61)
Mild	12(28.57)	13(30.95)	25(29.76)
Moderate	14(33.33)	09(21.42)	23(27.38)
Vigorous	06(14.28)	08(19)	14(16.66)

Table-2: Pain intensity and low-back disability in group A and B.

	Descriptive Statistics			
Outcomes	**Group**	**n**	**Mean±SD**	***p*-value**
Numeric Pain Rating				
Baseline	Group A	42	6.62±1.04	0.00
measurement	Group B	42	6.50±1.24	
After 4th Session	Group A	42	5.52±0.97	0.00
	Group B	42	4.78±0.97	
After 8th Session	Group A	42	4.44±0.90	0.00
	Group B	42	3.10±0.76	
After 12th Session	Group A	42	3.32±0.81	0.00
	Group B	42	1.00±0.60	
Low Back Disability Index				
Baseline	Group A	42	65.08±8.94	0.00
measurement	Group B	42	69.16±9.13	
After 4th Session	Group A	42	57.60±8.47	0.00
	Group B	42	52.64±8.38	
After 8th Session	Group A	42	49.64±8.44	0.00
	Group B	42	35.56±8.19	
After 12th Session	Group A	42	40.56±8.59	0.00
	Group B	42	16.04±6.82	

SD: Standard Deviation.

Table-3: Inter-group comparison.

	Group Statistics						
Outcomes	**Group**	**n**	**t**	**Mean Difference**	**Mean±SD**	**SD Error Mean**	**Sig. (2-tailed)**
Numeric Pain Rating							
Baseline	Group A	42	-2.25	-4.08	65.08±8.94	1.26	0.02
measurement	Group B	42	-2.25	-4.08	69.16±9.13	1.29	0.02
After 4th	Group A	42	2.94	4.96	57.60±8.47	1.19	0.00
session	Group B	42	2.94	4.96	52.64±8.38	1.18	0.00
After 8th	Group A	42	8.46	14.08	49.64±8.44	1.19	0.00
session	Group B	42	8.46	14.08	35.56±8.19	1.15	0.00
After 12th	Group A	42	15.80	24.52	40.56±8.59	1.21	0.00
session	Group B	42	15.80	24.52	16.04±6.82	.96	0.00
Low Back Disability Index							
Baseline	Group A	42	0.52	0.12	6.62±1.047	0.14	0.60
measurement	Group B	42	0.52	0.12	6.50±1.249	0.17	0.60
After 4th	Group A	42	3.79	0.74	5.52±0.97	0.13	0.00
session	Group B	42	3.79	0.74	4.78±0.97	0.13	0.00
After 8th	Group A	42	7.99	1.34	4.44±0.90	0.12	0.00
session	Group B	42	7.99	1.34	3.10±0.76	0.10	0.00
After 12th	Group A	42	16.09	2.32	3.32±0.81	0.11	0.00
session	Group B	42	16.09	2.32	1.00±0.60	0.08	0.00

SD: Standard Deviation.

Discussion

The current study found significant intra-group improvement in terms of pain and disability in CLBP patients, with VRE showing significantly more improvement than RPT.

A study compared traditionally used trunk exercises and core stability exercises, reporting improvement in both groups, with inter-group comparison showing no significant difference.[22]

A study reported significant improvement with High-Frequency Spinal Cord Stimulation for CLBP patients.[23]

One study used VREs to reduce pain and kinesio-phobia in patients with chronic pain. Virtual-walking-integrated physiotherapy reduced pain and improved function, but the study had a short follow-up.[24] In the current study, patients were followed-up over 12 sessions.

The association of functional index and low-back is inverse, as the low-back can limit body movements and results in compromised functions of the lower spinal area. A meta-analysis stated that patients with CLBP had low functional status, self-efficacy for physical functioning, and high pain intensity compared to the acute cases.[25]

One study measuring the effectiveness of spinal stabilisation exercises proved that exercise had a key role. The combination of latissimus dorsi further increased its effectiveness in managing pain and functional index in LBP subjects.[26] VRE-based exercises induce strength in muscles of the lumbar spine and induce stability and self-control. The role of lumbar stabilisation and strengthening exercises for the management of pain and disability had significant impact on disability index and decreased pain intensity.[27] Gamified environments with VREs resulted in improvement in pain and behavioural health, and VREs improved chronic pain both in clinical and home settings.[28]

Chronic musculoskeletal conditions compromise functional activities and range of movement. VRE-based interventions improve the outcome, including pain intensity and functional index, and improve quality of life because they indirectly reduce fear-avoidance during movement. A recent review supported the VR treatment as having a significant effect on pain, joint mobility and motor function of patients with chronic musculoskeletal disorders.[29]

The current study has limitations as it only comprised subjects aged 25-50 years. Further studies are needed, especially among the elderly, to address fear-avoidance of movement using VRE-based exercises.

Conclusion

VREs were found to be effective in combination with RPT compared to RPT alone.

Disclaimer: The text is based on a PhD thesis.

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