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EFFECT OF VIRTUAL REALITY–BASED TRAINING VERSUS CONVENTIONAL PHYSIOTHERAPY TRAINING ON PAIN, DISABILITY, AND CERVICAL RANGE OF MOTION IN PATIENTS WITH CHRONIC NECK PAIN: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Chronic neck pain is a common musculoskeletal disorder leading to persistent pain, functional disability, and reduced cervical mobility. Virtual reality (VR)–based rehabilitation has emerged as a novel therapeutic approach that enhances engagement and neuromuscular retraining.

Objective: To compare the effectiveness of conventional physiotherapy training and virtual reality–based training on pain, disability, and cervical range of motion in patients with chronic neck pain.

Methods: A randomized controlled trial was conducted on 60 patients with chronic neck pain. Participants were randomly allocated into Group A (conventional physiotherapy, n = 30) and Group B (virtual reality–based training, n = 30). Both groups received treatment for 6 weeks. Outcome measures included Visual Analog Scale (VAS), Neck Disability Index (NDI), and cervical range of motion measured using a goniometer. Pre- and post-intervention assessments were performed. Statistical analysis was done using paired and independent t-tests.

Results: Both groups showed statistically significant improvements in pain, disability, and cervical range of motion ($p < 0.001$). However, Group B demonstrated significantly greater improvement compared to Group A in all parameters.

Conclusion: Virtual reality–based training is more effective than conventional physiotherapy in improving pain, disability, and cervical mobility in patients with chronic neck pain.

Keywords: Chronic neck pain, Virtual reality, Physiotherapy, Rehabilitation, Range of motion

INTRODUCTION

Chronic neck pain (CNP) is one of the most prevalent musculoskeletal disorders worldwide and represents a significant public health concern due to its high recurrence rate, associated disability, and socioeconomic burden. Epidemiological studies indicate that the lifetime prevalence of neck pain ranges from 14% to 71%, with a substantial proportion of individuals developing chronic symptoms lasting longer than 12 weeks **[1, 2]**. Prolonged sitting postures, sustained forward head position, repetitive movements, psychosocial stress, and sedentary lifestyles contribute significantly to the development of chronic neck pain **[3]**.

The pathophysiology of chronic neck pain is multifactorial, involving biomechanical, neuromuscular, and neurophysiological mechanisms. Sustained abnormal cervical loading leads to muscular fatigue, myofascial trigger point formation, altered motor control, and impaired proprioception **[4, 5]**. In addition, persistent nociceptive input can result in central sensitization, cortical reorganization, and altered pain modulation, contributing to chronicity and movement-related fear **[6, 7]**. These factors collectively lead to pain, restricted cervical mobility, functional disability, and reduced quality of life.

Conventional physiotherapy interventions, including stretching, strengthening, joint mobilization, and postural correction exercises, have demonstrated beneficial effects in reducing pain and improving function in patients with chronic neck pain [8,9]. Therapeutic exercises restore cervical biomechanics, enhance muscular endurance, improve neuromuscular coordination, and reduce fear-avoidance behaviour [10]. However, adherence to exercise programs and patient motivation remain significant challenges in achieving optimal rehabilitation outcomes.

Virtual reality (VR)–based rehabilitation is an emerging therapeutic approach that utilizes immersive digital environments to enhance patient engagement, motor learning, and sensory feedback. VR-based interventions provide real-time visual feedback, task-specific movement training, and multisensory stimulation, facilitating neuroplastic adaptation and improved motor

control **[11, 12]**. Studies have demonstrated that VR-based training improves balance, proprioception, joint range of motion, and functional performance in neurological and musculoskeletal populations **[13–15]**.

Recent research has highlighted the analgesic effects of virtual reality through distraction mechanisms, cortical modulation, and altered pain perception **[16, 17]**. In musculoskeletal rehabilitation, VR training has shown promising results in reducing pain, improving joint mobility, and enhancing functional outcomes in conditions such as low back pain, shoulder disorders, and knee osteoarthritis **[18–20]**. However, limited randomized controlled trials have specifically examined the effectiveness of VR-based rehabilitation in patients with chronic neck pain.

Therefore, the present study aimed to compare the effects of conventional physiotherapy training and virtual reality–based training on pain, functional disability, and cervical range of motion in patients with chronic neck pain.

MATERIALS AND METHODS

Study Design - Randomized controlled trial.

Study Setting- Physiotherapy outpatient department.

Sample Size - 60 patients with chronic neck pain.

Sampling Technique - Simple random sampling.

Group Allocation

Group A: Conventional physiotherapy training (n = 30)

Group B: Virtual reality–based training (n = 30)

Inclusion criteria:

1. Age between 35 to 65 years
2. Chronic neck pain (>3 months) confirmed by a healthcare professional
3. Pain intensity ≥4/10 on the VAS
4. Reduced neck mobility

Exclusion criteria:

1. Recent severe neck trauma or surgery
2. Underlying neurological conditions (e.g., multiple sclerosis, Parkinson's disease)
3. Pregnant or breastfeeding women
4. Uncontrolled medical conditions: (e.g., diabetes, hypertension) that may impact participation.

Outcome Measures

Visual Analog Scale (VAS)

Neck Disability Index (NDI)

Cervical range of motion using goniometer

Statistical Analysis

Data analysis was performed using SPSS software. Paired t-test was used for within-group comparisons, and independent t-test for between-group comparisons. Statistical significance was set at $p < 0.05$.

INTERVENTION DETAILS

Before starting all exercises participants have to perform Warm-up (5 minutes)-stretching exercises to relax the neck and shoulder muscles Exercise

Table 1: Exercise Program

Week	Control Group	Experimental group (With VR)
1	Neck flexion and Extension Neck side flexion Neck rotation Levator scapulae stretch	Neck flexion and Extension Neck side flexion Neck rotation Levator scapulae stretch
2	Chin tucks (10 x 3) thoracic extension (10 x 3) Scapular squeeze (10 x 3)	Chin tucks (10 x 3) thoracic extension (10 x 3) Scapular squeeze (10 x 3)
3	Isometric neck flexion (10 x 3) Isometric neck extension (10 x 3) Isometric neck side bend (10 x 3)	Isometric neck flexion (10 x 3) Isometric neck extension (10 x 3) Isometric neck side bend (10 x 3)
4	Shoulder shrugs (10 x 3) Shoulder rolls (10 x 3) Head lifts (10 x 3)	Shoulder shrugs (10 x 3) Shoulder rolls (10 x 3) Head lifts (10 x 3)

After completing all exercises participants have to perform Cool-down (5 minutes)- Virtual meditation or deep breathing exercises to relax the neck and shoulder muscle

RESULTS

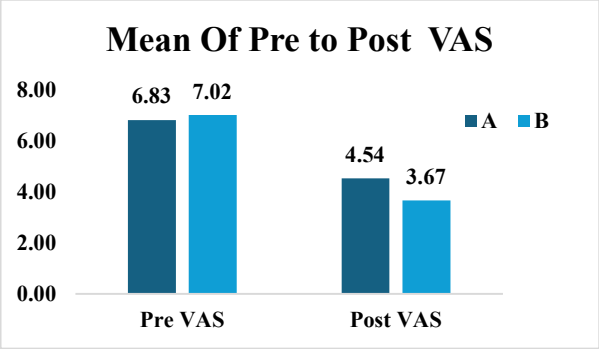
We test Normality distribution test for all outcomes measure for both Groups, based on Shapiro-wilk test most of outcomes measure our null hypothesis is accepted for both Group and assume all outcomes measure are normally distributed. So, we can use parametric test for statistical significant.

Here within group of **A** & **B** analysis by Pair T Test, P value is <0.001. Here we can say that statistical highly significance for both group from pre to post comparison in within group.

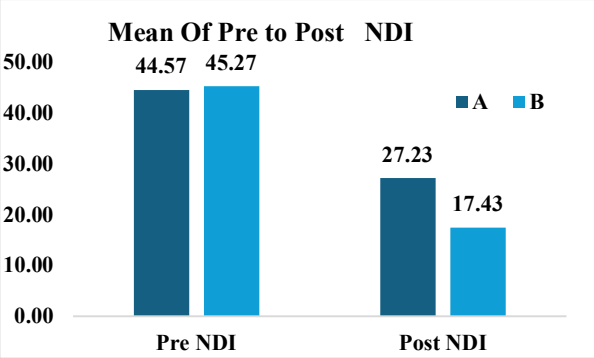
Table 2: Group of A & B analysis by Pair T Test

Outcomes Measures	A			B			P-VALUE (between group)
	Mean	SD	P-VALUE	Mean	SD	P-VALUE	
Pre VAS	6.83	0.52	P<0.001	7.02	0.64	P<0.001	0.227
Post VAS	4.54	0.75		3.67	0.69		0.001
Pre NDI	44.57	6.71	P<0.001	45.27	5.58	P<0.001	0.662
Post NDI	27.23	8.27		17.43	5.66		0.001
Pre Cervical Flexion	34.93	2.74	P<0.001	34.77	3.02	P<0.001	0.824
Post Cervical Flexion	43.07	2.48		49.97	2.72		0.001
Pre Cervical Extension	28.23	2.97	P<0.001	28.47	3.15	P<0.001	0.769
Post Cervical Extension	43.70	2.26		50.03	3.19		0.001
Pre left Cervical Side Flexion	24.57	3.16	P<0.001	24.13	2.90	P<0.001	0.582
Post left Cervical Side Flexion	38.83	2.73		45.53	2.94		0.001
pre right cervical side flexion	24.57	3.16	P<0.001	24.13	2.90	P<0.001	0.582
post right cervical side flexion	38.83	2.73		45.53	2.94		0.001

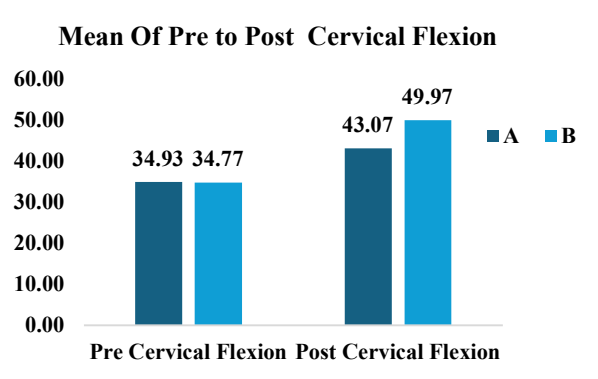
Between Group **A** & **B** analysis Two Sample T Test. P value of Pre-to-Pre comparisons non significance and Post to Post P Value <0.05 statistically significance so we can say that both Group are effective but Group **B** is better than Group **A**. (Except only Cervical Flexion).



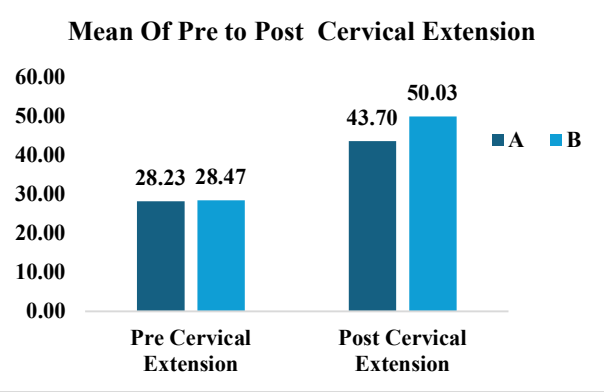
Graph 1: Mean Of Pre to Post Intervention of VAS



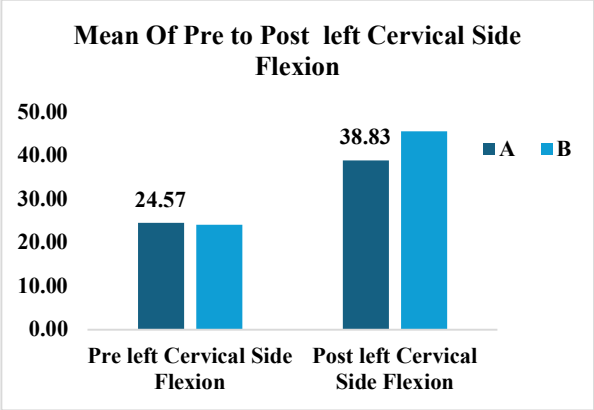
Graph 2: Mean of Pre to Post Intervention of NDI



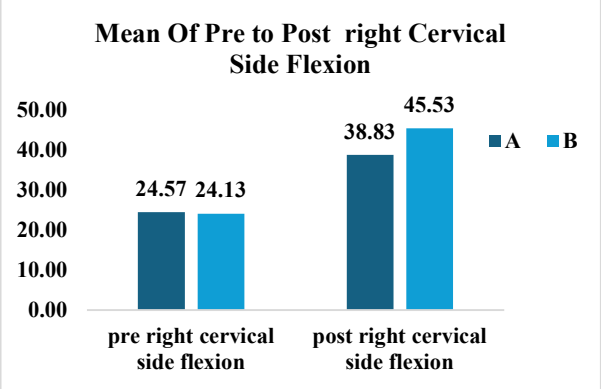
Graph 3: Mean Of Pre to Post of Intervention of Cervical Flexion



Graph 4: Mean Of Pre to Post Intervention of Cervical Extension



Graph 5: Mean of Pre to Post of Intervention of left Cervical Side Flexion



Graph 6: Mean Of Pre to Post of Intervention of right Cervical Side Flexion

Based on the findings of the study, it can be concluded both conventional and VR based training are effective in reducing pain, improving functional ability and increasing range of motion in patients with chronic neck pain.

DISCUSSION

The present randomized controlled trial investigated the comparative effectiveness of conventional physiotherapy training and virtual reality–based training on pain intensity, functional disability, and cervical range of motion in patients with chronic neck pain. The results demonstrated statistically significant improvements in all outcome measures in both groups following intervention. However, participants who received virtual reality–based training exhibited significantly superior improvements, particularly in cervical mobility and pain reduction.

Pain reduction observed in the conventional physiotherapy group can be attributed to the effects of stretching, strengthening, and mobility exercises, which reduce muscle spasm, improve circulation, restore cervical biomechanics, and enhance neuromuscular coordination **[8, 9]**. Therapeutic exercise has been shown to decrease nociceptive input, improve muscular balance, and normalize

movement patterns, leading to reduced pain perception **[10, 21]**. These findings are consistent with previous studies reporting significant reductions in pain intensity following structured physiotherapy programs in individuals with chronic neck pain **[22, 23]**.

The superior pain reduction observed in the VR group may be explained by the multisensory engagement and distraction mechanisms inherent to immersive virtual environments. Virtual reality modulates pain perception by diverting attention away from nociceptive stimuli, activating cortical pain inhibitory pathways, and enhancing cognitive engagement **[16, 17]**. Hoffman *et al*. reported significant analgesic effects of VR distraction therapy during painful rehabilitation procedures, suggesting that immersive environments effectively reduce pain perception **[24]**. Furthermore, repeated exposure to pain-free movements in VR may reduce fear-avoidance behaviour and movement-related anxiety, facilitating improved functional outcomes **[25]**.

Significant improvement in functional disability was observed in both groups, as reflected by reduced NDI scores post-intervention. Improvement in the conventional group aligns with evidence suggesting that therapeutic exercise improves postural control, neuromuscular efficiency, and functional performance in patients with neck pain **[9, 21]**. However, the VR group demonstrated significantly greater functional improvement, likely due to task-specific, goal-directed training that simulates real-life movements. VR-based interventions promote greater motivation, adherence, and movement repetition, all of which are essential for motor relearning and functional recovery **[12, 26]**.

Previous studies have demonstrated that VR training enhances functional outcomes by improving sensorimotor integration, motor planning, and movement accuracy **[13, 14]**. Lee *et al*. reported that VR-based exercise significantly improved pain and functional performance in patients with chronic neck pain compared to conventional therapy alone **[27]**. Similarly, Kim *et al*. observed superior improvements in disability and postural control following VR-based rehabilitation **[28]**.

Both groups exhibited significant improvements in cervical range of motion following intervention. Improvements in the conventional group may be attributed to muscle stretching, joint mobilization effects, and reduced pain-related movement inhibition **[8, 9]**. Restoration of cervical flexibility and reduction of muscular tightness are essential components of conventional physiotherapy management **[10]**.

However, the VR group demonstrated significantly greater improvements in cervical flexion, extension, and bilateral side

flexion. This superior outcome may be explained by the provision of real-time visual feedback, enhanced proprioceptive input, and repetitive movement execution facilitated by VR training. Visual feedback has been shown to improve movement accuracy, proprioception, and neuromuscular control, which are often impaired in chronic neck pain patients **[5, 29]**. Treleaven *et al*. reported that impaired cervical proprioception contributes to movement dysfunction in neck pain, and training approaches incorporating visual feedback significantly enhance rehabilitation outcomes **[30]**.

Additionally, VR environments encourage repeated movement execution in a pain-free and enjoyable manner, facilitating cortical reorganization and neuroplastic adaptation **[12, 31]**. Studies have demonstrated superior improvements in joint mobility following VR-based rehabilitation compared to conventional therapy alone in various musculoskeletal conditions **[18, 32]**.

Overall, the findings of the present study support growing evidence that virtual reality–based rehabilitation provides an additive therapeutic advantage over conventional physiotherapy in the management of chronic neck pain. The enhanced engagement, motivation, and sensory feedback associated with VR training appear to contribute to superior improvements in pain reduction, functional performance, and cervical mobility.

CONCLUSION

According to the outcomes of this study, individuals with persistent neck pain can benefit from both traditional physiotherapy training and virtual reality-based training in relations of discomfort decrease, practical volume enhancement, and cervical range of motion. However, virtual reality–based training demonstrated superior outcomes compared to conventional physiotherapy alone, particularly in relations of cervical range and functional improvement. The immersive, interactive, and feedback-oriented nature of virtual reality training appears to enhance motor performance, patient motivation, and treatment adherence.

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REFERENCES

[1] Côté P, van der Velde G, Cassidy JD, Carroll LJ, Hogg-Johnson S, Holm LW, *et al*. The burden and determinants of neck pain in workers. Eur Spine J. 2008; 17(Suppl 1): S60–74.

[2] Hoy DG, Protani M, De R, Buchbinder R. The epidemiology of neck pain. Best Pract Res Clin Rheumatol. 2010;24(6):783–792.

[3] Ariëns GA, Bongers PM, Douwes M, Miedema MC, Hoogendoorn WE, van der Wal G, *et al*. Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Occup Environ Med. 2001;58(3):200–207.

[4] Falla D, Jull G, Hodges P. Feedforward activity of the cervical flexor muscles during voluntary arm movements is delayed in chronic neck pain. Exp Brain Res. 2004;157(1):43–48.

[5] Röijezon U, Clark NC, Treleaven J. Proprioception in musculoskeletal rehabilitation. Man Ther. 2015;20(6):852–858.

[6] Woolf CJ. Central sensitization: Implications for the diagnosis and treatment of pain. Pain. 2011;152(Suppl 3):S2–S15.

[7] Sterling M. Differential development of sensory hypersensitivity and spinal cord hyperexcitability following whiplash injury. Pain. 2003;104(3):509–517.

[8] Gross AR, Paquin JP, Dupont G, Blanchette S, Lalonde P, Cristie T, *et al*. Exercises for mechanical neck disorders. Cochrane Database Syst Rev. 2015;1:CD004250.

[9] Kay TM, Gross A, Goldsmith CH, Rutherford S, Voth S, Hoving JL, *et al*. Exercises for mechanical neck disorders. Phys Ther. 2012;92(7):912–927.

[10] Ylinen J, Takala EP, Nykänen M, Häkkinen A, Mälkiä E, Pohjolainen T, *et al*. Active neck muscle training in chronic neck pain. JAMA. 2003;289(19):2509–2516.

[11] Riva G, Wiederhold BK, Mantovani F. Neuroscience of virtual reality. Cyberpsychol Behav Soc Netw. 2019;22(1):82–96.

[12] Levin MF, Weiss PL, Keshner EA. Emergence of virtual reality as a tool for rehabilitation. Phys Ther. 2015;95(3):415–425.

[13] Holden MK. Virtual environments for motor rehabilitation. Cyberpsychol Behav. 2005;8(3):187–211.

[14] Laver KE, Lange B, George S, Deutsch JE, Saposnik G, Crotty M. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev. 2017;11:CD008349.

[15] Kim SY, Kim YM, Lee DK. Effects of virtual reality training on balance and cervical range of motion. Ann Rehabil Med. 2014;38(4):523–531.

[16] Mallari B, Spaeth EK, Goh H, Boyd BS. Virtual reality as an analgesic. Clin J Pain. 2019;35(5):402–415.

[17] Hoffman HG, Chambers GT, Meyer WJ, Arceneaux LL, Russell WJ, Seibel EJ, *et al*. Virtual reality distraction for pain control. Pain. 2011;152(8):1634–1641.

[18] Garcia LM, Birckhead BJ, Krishnamurthy P, Mackey IG, Louis RG, Salmasi V, *et al*. Self-administered virtual reality for chronic neck pain. Pain Med. 2021;22(9):2048–2057.

[19] Li L, Yu F, Shi D, Shi J, Tian Z, Yang J, *et al*. Virtual reality rehabilitation in musculoskeletal disorders. Clin Rehabil. 2018;32(5):594–603.

[20] Chen Y, Fanchiang HD, Howard A. Effectiveness of virtual reality training. Comput Hum Behav. 2018;88:292–298.

[21] Jull G, Sterling M, Falla D, Treleaven J, O'Leary S. Whiplash, Headache, and Neck Pain: Research-Based Directions for Physical Therapies. Edinburgh: Elsevier; 2008.

[22] Sihawong R, Janwantanakul P, Sitthipornvorakul E, Pensri P. Exercise therapy for office workers with nonspecific neck pain. J Manipulative Physiol Ther. 2011;34(2):62–71.

[23] Andersen LL, Saervoll CA, Mortensen OS, Poulsen OM, Hannerz H, Zebis MK. Effectiveness of physical training on chronic neck pain. Arthritis Rheum. 2008;59(1):84–91.

[24] Hoffman HG, Patterson DR, Carrougher GJ. Virtual reality for burn pain during physiotherapy. Pain. 2000;85(1–2):305–309.

[25] Vlaeyen JWS, Linton SJ. Fear-avoidance model of chronic musculoskeletal pain. Pain. 2000;85(3):317–332.

[26] Weiss PL, Keshner EA, Levin MF. Virtual Reality and Motor Rehabilitation. New York: Springer; 2014.

[27] Lee HS, Kim YJ, Lee DK. Effect of virtual reality exercise on chronic neck pain. J Phys Ther Sci. 2016;28(5):1513–1516.

[28] Kim YM, Chun MH, Yun GJ, Song YJ, Young HE. Virtual reality rehabilitation in stroke. Neuro Rehabilitation. 2011; 29(3): 223–229.

[29] Revel M, Andre-Deshays C, Minguet M. Cervicocephalic kinesthetic sensibility. Arch Phys Med Rehabil. 1991;72(5):288–291.

[30] Treleaven J, Jull G, LowChoy N. Smooth pursuit neck torsion test. Spine. 2005;30(1):E41–E48.

[31] Caggiano V, Sgandurra G, Carmignani A, Palermo C, Bucci S,

Ciampi L, *et al*. VR vs conventional therapy trial. Disabil Rehabil. 2019;41(19):2314–2322.

[32] Park JH, Kim YJ, Kim YL. Virtual reality exercise for neck pain. J Phys Ther Sci. 2015;27(12):3725–3728.