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Research Article

EFFECTIVENESS OF VIRTUAL REALITY ON FUNCTIONAL OUTCOME IN MEDIAN NERVE INJURED PATIENTS

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ABSTRACT

Objectives: Injuries to the median nerve, frequently caused by trauma or repetitive strain, may result in significant functional limitations, motor and sensory deficits. Virtual reality (VR) is increasingly recognized in neurological rehabilitation, but there is limited information in the literature regarding this topic. This study aims to evaluate the effectiveness of VR treatments on functional outcomes in patients with median nerve injuries.

Methods: In an experimental study, 40 median nerve injury patients were split into two categories according to inclusion and exclusion standards by simple random sampling method in a private setting. The conventional rehabilitation (CR) was administered in Group 1 (n=20), while the VR therapy in Group 2 (n=20). As outcome measures, Hand Held Dynamometer (HHD) and the Nine Hole Peg Test (NHPT) scale were used.

Results: VR therapy and CR demonstrated enhancements in functional results for people with median nerve injuries, but the post-test results in Group 2 showed a greater mean in HHD (17.85) than in Group 1 (13.10). The average difference in the NHPT was 35.95 for Group 1 and 21.25 for Group 2, suggesting that VR enhances functional results.

Conclusion: VR therapy and CR showed statistically significant improvements in the functional outcomes of patients with median nerve injuries, whereas VR therapy demonstrated greater enhancement of motor skills. This evidence supports VR therapy as a feasible option to conventional approaches.

Keywords: Conventional therapy, Nine-hole peg test, Handheld dynamometer, Motor recovery, Nerve regeneration.

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INTRODUCTION

The median nerve is one of the five terminal branches of the brachial plexus [1]. The median nerve is formed by the lateral root that comes from the lateral cord and the medial root that emanates from the medial cord of the brachial plexus. The median nerve develops in front of or beside the axillary artery inside the axilla [2]. The median nerve acts as a sensory and motor nerve. It is the nerve responsible for wrist flexion, pronation of the thumb, index finger, middle finger, and along with the antepulsion and opposition of the thumb. Additionally it supplies the sensory innervation to the palm surface of the initial three fingers [3]. Damage to peripheral nerves is known as peripheral nerve injury and the most common causes of hand impairment stem from upper limb injuries [4]. The average national incidence of peripheral nerve injury is calculated as 11.2 occurrences for every 100,000 individuals annually [5]. Factors that lead to traumatic peripheral nerve injury encompass penetrating wounds, crush injuries, traction, ischemia, and rarer causes such as thermal exposure, electric shock, radiation, percussion, and vibration. Lacerations caused by objects such as glass, knives, fans, saw blades, car metal, or severe bone breaks account for approximately 30% of significant nerve injuries [6].

The median nerve on the periphery may experience compression beneath the fascial sheath of the flexor retinaculum, commonly resulting in burning sensations, numbness, discomfort, tingling sensations (neuropathic pain), and muscular weakness [7,8]. Clinical deficits associated with median nerve injuries consist of the inability to flex the thumb and index finger; numbness in the thumb, index, and middle finger pulp; and reduced strength in grasping and pinching [9]. The issues arising from median nerve injury and its repair are linked to unsatisfactory functional results. Injured nerves that remain unrepaired can lead to various issues, such as painful neuromas and the possibility of chronic regional pain syndrome [10].

All peripheral nerve injuries (PNI) up to 33% show inadequate nerve healing and functional results, which encompass the loss or limited recovery of motor and sensory abilities, persistent pain, along with muscle atrophy at the target site, and significant weakness [11]. Neuropathic pain also seen in most of PNI, it is a nerve pain feels such as burning, tingling, or shock-like pain for this statin may use to manage the pain symptoms [12], and for pain management, some extract from leaves (*Solenostemon monostachyus*) helps in suppression of pain [13].

The chances of regaining nerve function improve with a mild injury and a briefer period of compression. Recovery occurs more quickly when the repetitive actions that worsen the injury can be reduced or stopped. The first approach for numerous nerve injuries is non-operative [14]. More modern and creative method of neurological rehabilitation is virtual reality (VR)-based therapy, which makes use of rigorous, repeated, personalized, interactive practice [15]. Devices for VR interfaces serve as an effective means for creating therapies that enhance, range of motion, and functional independence and improve patient motor skills [16,17].

The purpose of this study was to investigate and contrast the benefits of VR therapy and Conventional Rehabilitation (CR) on the functional outcomes of patients with median nerve injuries. The study intended to provide some insight into the feasibility of VR as an alternative method for treating nerve injuries.

METHODS

A comparative analysis was performed on individuals with median nerve damage in a private setting. The sample size for this study was determined using G Power 3.1 software. A priori power analysis was conducted with the following parameters: A significance level (α) of

0.05, a power (1-β) of 0.70, and an expected effect size (Cohen's d) of 0.6, based on previous research in median nerve rehabilitation. This yielded an estimated sample size of 126 participants. Due to participant dropouts and exclusions, the final analyzed sample consisted of 40 participants (Fig. 1). A *post hoc* power analysis confirmed that the study retained adequate power to detect large effects (Cohen's d=0.9). The research was explained to all 40 participants and informed consent was obtained. The participants were randomly divided into two groups by simple random sampling using lottery method: Group 1 (n=20) and Group 2 (n=20). Eligible participants underwent a pre-test evaluation, and the baseline values were documented. The randomization process was concealed from assessors to reduce selection bias. Group 1 received CR exercises for 35 min while Group 2 received VR therapy for the same duration. Both interventions were administered 5 days a week over a 6-week period. After completing the 6-week program, post-test outcome measures were recorded to assess treatment effectiveness.

This research was performed following the ethical standards established by the Institutional Ethical Committee for Human Experimentation under ISRB No 383/07/2024/ISRB/UGSR/SCPT

Inclusion criteria

- Age above 18 years
- Post-operative patients (after 4 weeks)
- Numbness and paresthesia in the median nerve distributions
- Nocturnal awakening of the above symptoms
- Weakness of thumb abduction and thenar atrophy
- Neuropraxic, axonotmesis, or neurotmesis of the median nerve
- Sudden traumatic injuries, including cuts, breaks, dislocations, or bruises lead to injury of the median nerve.

Exclusion criteria

- Presence of other neurologic conditions
- Previous carpal tunnel release
- Cognitive impairment that renders the patient incapable of providing consent
- History of seizure
- Kidney disease/renal impairment
- Migraines or headache
- Hearing impairment
- Visual impairment.

Procedure

VR therapy

The VR intervention was performed using the Oculus Rift VR headset together with motion tracking controllers and a haptic feedback system. Patients received 35 min interactive video sessions for a total of 5 days a week over the course of 6 weeks. The VR therapy group had undergone BOX VR and VR BOWLING. VR boxing game involves actions such as punches and blocks. Punching leads elbow extension, wrist pronation. Blocks involve elbow flexion, elbow and wrist rotation. VR bowling games include holding, tossing and letting go of the ball, which activate various muscles and joints. The patient performed each game for 15 min with an interval of 5 min rest for 2 repetitions. The VR game was made up of tasks directed at improving hand function and coordination, with increasing complexity according to patient progression. Clear instructions were given to the patients at the beginning of each session. Materials included a VR headset, hand controllers, and custom rehabilitation software geared toward fine motor skill training [18,19].

CR

The conventional rehabilitation program for median nerve injuries consisted mainly of improving the patient's hand function and restoring use of the injured hand. Fine motor coordination exercises using therapeutic putty and small weights were employed to improve grip strength and overall dexterity [20]. In addition, active and passive motion exercises involving wrist, elbow, and finger were provided, respectively. They were executed to restore mobility and reduce stiffness. The patients were trained to do exercises properly with a gradual increase of resistance or intensity to avoid strain or risk of injury. The exercise sessions varied according to the severity of injury. The therapy is given on 10–15 repetitions for 35 min/day and 5 days a week for a totally 6 weeks.

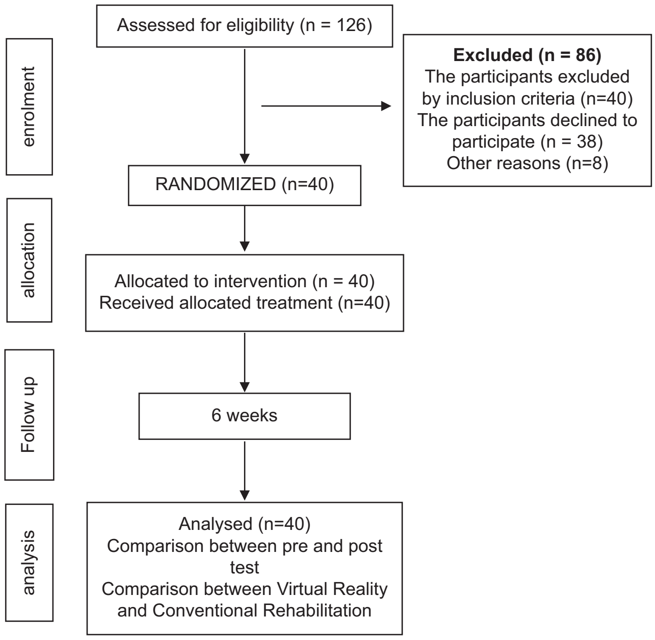

Fig. 1: Study enrolment flowchart

Outcome measure

Hand-Held-Dynamometer (HHD)

HHD is a technique employed to evaluate muscle strength. HHDs are restricted to assessing strength under two situations usually referred to as "make" or "break" test. "Make" tests require to ensure the dynamometer remains stable as the subject exerts force on it, while the "break" test consists of stopping the muscle contraction. Issues related to both techniques include the stabilization of the device and the strength. It is employed to assess muscle strength in physical therapy or clinical environments could have a capacity of 20–70 pounds or 9–32 kg, varying by model and the patient's capabilities.

The HHD has shown strong to outstanding reliability, with intraclass correlation coefficients (ICCs) ranging from 0.842 to 0.914. (HHDs) is evidenced by their broad application across a variety of populations, such as healthy older and younger adults, and patients with neurological or orthopedic disorders. HHDs have been calibrated for the measurement of strength in many muscle groups including upper and lower extremities ranging between 0.60 and 0.79 [21].

Nine Hole Peg Test (NHPT)

The NHPT is utilized to assess finger dexterity in individuals with different neurological conditions. The NHPT involves participants placing and subsequently removing nine pegs from nine holes, one by one, as fast as they can. Approximately 53% of the variation in the NHPT score can be accounted for by muscle strength, thumb tactile sensitivity, and the existence of intention tremor. For an average healthy adult, the duration to finish the task with one hand is approximately 10–30 s. For individuals with motor challenges or neurological disorders, the duration to complete the task can be significantly extended, varying from 40 s to more than a minute, based on the degree of the impairment.

The NHPT has also been shown to have good intra-rater reliability with ICCs of up to 0.96. The NHPT has also been shown to have good

Table 1: Pre- and post-test values of NHPT scale in Groups 1 and 2

Groups	Pre-test Mean ± SD	Post-test Mean ± SD	t-value	p-value
Group 1 (n = 20)	47.45 ± 3.137	35.95 ± 3.300	18.747	<0.001
Group 2 (n = 20)	45.50 ± 3.236	21.25 ± 5.149	18.460	<0.001

SD: Standard Deviation, NHPT: Nine-Hole Peg Test

Table 2: Pre and post-test values of HHD scale in Groups 1 and 2

Groups	Pre-test Mean ± SD	Post-test Mean ± SD	t-value	p-value
Group 1 (n = 20)	3.05 ± 1.395	13.10 ± 1.410	−20.320	<0.001
Group 2 (n = 20)	3.30 ± 1.490	17.85 ± 1.731	−25.374	<0.001

SD: Standard Deviation, HHD: Hand-Held Dynamometer

Table 3: Comparison of post-test values of HHD and NHPT in Group 1

Test	Mean	SD value	t-value	p-value
Post-test (HHD)	13.10	1.410	−10.204	<0.001
Post-test (NHPT)	35.95	3.300	−10.749	<0.001

SD: Standard Deviation, HHD: Hand-Held Dynamometer, NHPT: Nine-Hole Peg Test

Table 4: Comparison of post-test values of HHD and NHPT in Group 2

Test	Mean	SD value	t-value	p-value
Post-test (HHD)	17.85	1.531	−10.204	<0.001
Post-test (NHPT)	21.25	5.149	−10.749	<0.001

SD: Standard deviation, HHD: Hand-held dynamometer, NHPT: Nine-hole peg test

correlations with other dexterity and motor function measures, which also validates it as a valid tool for the assessment of fine motor skills [22].

Data analysis

The statistical procedure done in this project was determined employing the IBM Statistical Packages for the Social Sciences software Version 29 and data were analyzed using 95% confidence interval. The statistical analysis method aims to assess the impact of VR therapy versus CR on patients with median nerve injuries. Descriptive statistics, including mean and standard deviation (SD), were initially computed for pre-test and post-test results on the NHPT and HHD. A paired t-test was conducted to assess improvements within the group from pre-test to post-test for every intervention. An independent t-test was employed to analyze the post-test outcomes of both groups.

RESULTS

The statistical analyses were carried out, according to the analysis performed on the data collected from the subjects, the post-test mean value and SD of the NHPT scale in Group 1 was 35.95±3.300, while in Group 2, it was 21.25±5.149. In addition, the post-test values for HHD scale were 13.10±1.531 for Group 1 and 17.85±1.531 for Group 2. The effect size obtained by Cohen's d for post-NHPT is 3.40 and for post-HHD is 3.11. A notable difference was found in the post-test values of Groups 1 and 2 for both outcome measures, with a p-value lower than 0.001. An excellent statistical difference was obtained from the tests between the groups. VR therapy and CR showed improvements in functional outcomes for individuals with median nerve injuries and it enhances in grip strength and fine motor abilities, but VR has superior effect compared to CR. The statistical analyses was explained in the Tables 1-4.

DISCUSSION

In this study, we observed that Group 2 undergoing VR therapy had a greater effect on median nerve injury when compared to Group 1 undergoing CR. The post-test values gained from this group were significant having a p<0.001 but Group 2 showed a higher mean difference compared to Group 1 in this comparative study, the respondents of Group 2 had greater improvements in the scales of HHD and NHPT than the respondents in Group 1.

In our research, we discovered that patients undergoing VR therapy exhibited superior outcomes in recovering from median nerve injuries compared to those receiving CR. The findings of (Kiper *et al*., 2018), support that VR elicited better results with the combination of reinforced feedback in the VR environment compared to Conventional Rehabilitation for upper limb recovery [23]. However, a counter-studied fact was provided by (Laver *et al*., 2017) indicates that VR and interactive video gaming were not found to produce outcomes superior to CR in enhancing upper limb motor skills [24].

The application of VR positively impacts the rehabilitation of the upper limb for patients with nerve damage, exhibiting minimal side effects and serving as a non-pharmacological treatment. The VR engages in intense, repetitive, and focused activities, enhancing strength, flexibility, and coordination in patients and also reduces pain. Overall, VR therapy leads to significantly better clinical outcomes and quality of life for patients with nerve injuries than CR. As (Ikbali Afsar *et al*. 2018) state the installation of VR games provides focused movements that particularly improve the strength of the affected upper limb, giving distinct advantages over CR [25]. VR therapy offers interactive and immersive experiences that increase patient engagement in the study. VR systems can be configured to tailor rehabilitation exercises based on the individual requirements of the patients accordingly. Motion sensors in VR systems monitor patient's hand functions and motor skills in real-time and help to improve rehabilitation. This provides valuable feedback on the patient's recovery process and informs decisions about adjustments to the treatment plan which is performed in the study and other benefits of VR like, it also used in the management of cognition impairment in central nervous system disorder [26].

In our study, VR therapy showed significantly better clinical outcomes and quality of life in patients with nerve injury compared to CR. As an opposition, the findings of (Brochard *et al*. 2010), indicated that both interventions yield immediate benefits but traditional therapy shows a higher retention of motor skills and functional capabilities over the long run [27].

In CR treatment for median nerve injuries led to moderate improvement in outcomes for patients, but it was slow and less pronounced when compared with patients who underwent VR therapies. A study by (Choi and Paik, 2018), who created a mobile game-supported VR rehabilitation system for upper limb recovery, demonstrating that the program was both feasible and effective in improving recovery compared with CR [28]. However, the study supports the effectiveness of VR, it also shows similar initial advantages of both treatments, whereas long-term outcomes might still require further exploration to determine the sustained benefits of VR therapy.

In this study, we showed that VR therapy resulted in higher improvement rates compared to CR in patients with median nerve injuries. Our results were in consonance with previously obtained findings showing that VR had beneficial effects on the rehabilitation of the upper limb by increasing functional outcome, muscle strength, and coordination. Conversely, contradictory findings contradict any far-reaching conclusion about the long-term benefits of VR therapy, as traditional therapy has demonstrated a better retention of motor skills over time. The very nature of VR therapy, which involves almost no invasion and side effects, makes it a valid alternative to Conventional Rehabilitation and like VR therapy AI and AI-driven chatbots makes an revolution in research filed by comprehensive literature review, timely and effective solutions [29,30].

Limitations and recommendations of the study

The limitation of the study was that it did not provide for the long-term advantages or disadvantages of VR and standard therapy exercises post-intervention. The heterogeneity of the severity and extent of median nerve injuries between patients can influence the cumulative efficacy of VR treatments. Consequently, personalized treatment protocols might be necessary, but such personalization is typically resource-intensive and difficult to apply at scale. Future studies need to focus on larger-scale randomized controlled studies with extended follow-ups to help assess long-term beneficial effects. A standardized VR intervention for personalized functional deficits along with Conventional Rehabilitation could improve outcomes. Other recommended analyses for clinical implementation include cost-effectiveness and using of advance equipment's as outcome measure.

CONCLUSION

This research concluded that VR therapy exhibited significant functional outcome than patients who received CR. When assessed with the NHPT and HHD tests, patients undergone VR and CR had significant functional outcome performance, muscle strength, and movements.

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AUTHOR'S CONTRIBUTION

Dhanusia S- Conceptualization, Methodology, Investigation. Baroon Nallusamy- Data curation, formal analysis, writing original draft. Prathap Suganthirababu- Writing review and editing, supervision.

CONFLICTS OF INTEREST

The author stated that there are no conflicts of interest.

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REFERENCES

1. Murphy KA, Morrisonponce D. Anatomy, shoulder and upper limb, median nerve. In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2025 Jan. PMID 28846302
2. Ghosh B, Dilkash MN, Prasad S, Sinha SK. Anatomical variation of median nerve: Cadaveric study in brachial plexus. Anat Cell Biol. 2022 Jun 30;55(2):130-4. doi: 10.5115/acb.22.022, PMID 35718802, PMC9256496
3. Soubeyrand M, Melhem R, Protais M, Artuso M, Crézé M. Anatomy of the median nerve and its clinical applications. Hand Surg Rehabil. 2020 Feb;39(1):2-18. doi: 10.1016/j.hansur.2019.10.197, PMID 31816428
4. Griffin MF, Malahias M, Hindocha S, Khan WS. Peripheral nerve injury: Principles for repair and regeneration. Open Orthop J. 2014 Jun 27;8:199-203. doi: 10.2174/1874325001408010199, PMID 25067975, PMC4110386
5. Murphy RN, De Schoulepnikoff C, Chen JH, Columb MO, Bedford J, Wong JK, *et al*. The incidence and management of peripheral nerve injury in England (2005-2020). J Plast Reconstr Aesthet Surg. 2023 May;80:75-85. doi: 10.1016/j.bjps.2023.02.017, PMID 36996504
6. Campbell WW. Evaluation and management of peripheral nerve injury. Clin Neurophysiol. 2008 Sep;119(9):1951-65. doi: 10.1016/j.clinph.2008.03.018, PMID 18482862
7. Dydyk AM, Negrete G, Sarwan G, Cascella M. Median Nerve Injury. Treasure Island, FL: StatPearls Publishing; 2025 Jan.
8. Hussain G, Wang J, Rasul A, Anwar H, Qasim M, Zafar S, *et al*. Current status of therapeutic approaches against peripheral nerve injuries: A detailed story from injury to recovery. Int J Biol Sci. 2020 Jan 1;16(1):116-34. doi: 10.7150/ijbs.35653, PMID 31892850, PMC6930373
9. Soldado F, Bertelli JA, Ghizoni MF. High median nerve injury: Motor and sensory nerve transfers to restore function. Hand Clin. 2016 May;32(2):209-17. doi: 10.1016/j.hcl.2015.12.008, PMID 27094892
10. Pederson WC. Median nerve injury and repair. J Hand Surg Am. 2014 Jun;39(6):1216-22. doi: 10.1016/j.jhsa.2014.01.025, PMID 24862118
11. Wang ML, Rivlin M, Graham JG, Beredjiklian PK. Peripheral nerve injury, scarring, and recovery. Connect Tissue Res. 2019 Jan;60(1):3-9. doi: 10.1080/03008207.2018.1489381, PMID 30187777
12. Melkani I, Kumar B, Pandey NK, Baghel DS, Singh S. Statins: A new therapeutic approach for the treatment of neuropathic pain. Int J Appl Pharm. 2024;16(5):22-30. doi: 10.22159/ijap.2024v16i5.50456
13. Baba H, Bunu SJ. Spectroscopic and molecular docking analysis of phytoconstituent isolated from *Solenostemon* monostachyus as potential cyclooxygenase enzymes inhibitor. Int J Chem Res. 2025 Jan;9(1):1-6. doi: 10.22159/ijcr.2025v9i1.241
14. Neal S, Fields KB. Peripheral nerve entrapment and injury in the upper extremity. Am Fam Physician. 2010 Jan 15;81(2):147-55. PMID 20082510
15. Asirvatham T, Boppana A, Chandran PR, Kariyathankavil I, Al Abdulla SS. Virtual reality rehabilitation for optimizing function following radial nerve injury: A case report. Clin Neurol Neurosci. 2022;6(3):45-9.
16. Gatica-Rojas V, Méndez-Rebolledo G. Virtual reality interface devices in the reorganization of neural networks in the brain of patients with neurological diseases. Neural Regen Res. 2014 Apr 15;9(8):888-96. doi: 10.4103/1673-5374.131612, PMID 25206907, PMC4146258
17. Nishitha K, Anitha A, Thaheera D. Effectiveness of virtual reality-based rehabilitation and high-intensity exercise program for total knee arthroplasty patients: A randomised controlled trial. J Clin Diagn Res. 2024 Nov 1;18(11):YC01-8. doi: 10.7860/JCDR/2024/71122.20263
18. Holmes DE, Charles DK, Morrow PJ, McClean S, McDonough S. Evaluation of leap motion controller and oculus rift for virtual-reality-based upper limb stroke rehabilitation. J Altern Med Res. 2017 Oct 1;9(4):379-89.
19. Li Y, Jiang C, Li H, Su Y, Li M, Cao Y, *et al*. Combat sports in virtual reality for rehabilitation and disability adaptation: A mini-review. Front Public Health. 2025 Feb 27;13:1557338. doi: 10.3389/fpubh.2025.1557338, PMID 40084202, PMC11903427
20. Novak CB, Von Der Heyde RL. Evidence and techniques in rehabilitation following nerve injuries. Hand Clin. 2013 Aug;29(3):383-92. doi: 10.1016/j.hcl.2013.04.012, PMID 23895718
21. Chen B, Liu L, Bin Chen L, Cao X, Han P, Wang C, *et al*. Concurrent validity and reliability of a handheld dynamometer in measuring isometric shoulder rotational strength. J Sport Rehabil. 2021 Jan 19;30(6):965-8. doi: 10.1123/jsr.2020-0021, PMID 33465764
22. Mendoza-Sánchez S, Molina-Rueda F, Florencio LL, Carratalá-Tejada M, Cuesta-Gómez A. Reliability and agreement of the nine hole peg test in patients with unilateral spastic cerebral palsy. Eur J Pediatr. 2022 Jun;181(6):2283-90. doi: 10.1007/s00431-022-04423-w, PMID 35212827, PMC8873351
23. Kiper P, Szczudlik A, Agostini M, Opara J, Nowobilski R, Ventura L, *et al*. Virtual reality for upper limb rehabilitation in subacute and chronic stroke: A randomized controlled trial. Arch Phys Med Rehabil. 2018 May;99(5):834-42.e4. doi: 10.1016/j.apmr.2018.01.023, PMID 29453980
24. Laver KE, Lange B, George S, Deutsch JE, Saposnik G, Crotty M. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev. 2017 Nov 20;11(11):CD008349. doi: 10.1002/14651858.CD008349.pub4, PMID 29156493, PMC6485957
25. Ikbali Afsar S, Mirzayev I, Umit Yemisci O, Cosar Saracgil SN. Virtual reality in upper extremity rehabilitation of stroke patients: A randomized controlled trial. J Stroke Cerebrovasc Dis. 2018 Dec;27(12):3473-8. doi: 10.1016/j.jstrokecerebrovasdis.2018.08.007, PMID 30193810
26. Kouser N, Lohar D, Khan J, Vajpayee A. Assessment and management of cognition and motor impairment after stroke through exploratory data analysis and formulation of a model incorporating conventional existing and newer neuro-technology tools. Int J Curr Pharm Res.

2024 Sep;16(5):104-7. doi: 10.22159/ijcpr.2024v16i5.5088

27. Brochard S, Robertson J, Médée B, Rémy-Néris O. What's new in new technologies for upper extremity rehabilitation? Curr Opin Neurol. 2010 Dec;23(6):683-7. doi: 10.1097/WCO.0b013e32833f61ce, PMID 20852420
28. Choi YH, Paik NJ. Mobile game-based virtual reality program for upper extremity stroke rehabilitation. J Vis Exp. 2018 Mar 8;133:56241. doi: 10.3791/56241, PMID 29578520, PMC5931529
29. Malkawi R. Revolutionizing drug delivery innovation: Leveraging AI-driven chatbots for enhanced efficiency. Int J Appl Pharm. 2024;16(2):52-6. doi: 10.22159/ijap.2024v16i2.50182
30. Lalwani Y, Suvarna V. Global outlook on medical device industry. Int J Pharm Pharm Sci. 2021 Aug;13(8):1-8. doi: 10.22159/ijpps.2021v13i8.41372