Original Article

A randomised control trial on the use of bioinstrumentation and rehabilitation technology in hemiplegic patients

PRANALI PACHKHEDE[1], RASHMI WALKE[2]

[1]Final Year BPT Department Of Ravi Nair Physiotherapy College, Datta Meghe Institute Of Medical Sciences, Sawangi (Meghe), Wardha, Maharashtra, India

[2]Associated Professor, Department Of Cardio-Respiratory Physiotherapy, Ravi Nair Physiotherapy College, Datta Meghe Institute Of Medical Sciences,Sawangi (Meghe), Wardha, Maharashtra, India

Email: pranalipachkhede@gmail.com

DOI: 10.47750/pnr.2022.13.S06.399

Abstract

Stroke is a serious cerebrovascular disease characterized by sudden and acute onset and rapid neurological deficits, which is the world's leading cause of disability and the second leading cause of death, leaving 80% of patients having varying degrees of lifetime neurological deficits. As the global aging problem is getting worse, the positive correlation between stroke and age means that the incidence of stroke will only continue to rise. Stroke incidence is also trending toward even younger patients due to factors such as irregular work life and infrequent rest, a growing sense of pressure and anxiety, poor eating habits, and many other reasons. Hemiplegia is one of the most common symptoms of stroke and significantly affects the patient's quality of life by reducing their ability to perform activities of daily living. While the rehabilitation of hemiplegic stroke patients has commanded considerable attention in society and medicine, a severe shortage of rehabilitation therapists leads to inconsistent traditional rehabilitation training results. Thus, new treatments borne out of interdisciplinary medicine and engineering methods offer the potential to provide superior care for hemiplegic stroke patients. Such methods can not only promote the recovery of the patient by stimulating nerve remodeling, but also reduce physician workload. Bioinstruments use a variety of measurement modalities that are combined in a robotic hardware-based real-time acquisition and control environment and interpreted with the help of a computational model.

Keywords: Bioinstrumentation, rehabilitation technique, upperlimb, hemiplegia

INTRODUCTION

Stroke is defined as the sudden onset of clinical indications of localised or global brain function impairment that lasts more than 24 hours or results in death, with no other obvious cause other than vascular origin. Hemiplegia is a paralysis of one side of the body, affecting one upper and one lower extremity. Hemiplegia is a term that is typically used to refer to a wide range of motor impairments that can occur as a result of a stroke. The severity of neurological abnormalities in a particular patient is determined by the location and extent of brain injury, the amount of collateral blood flow, and the treatment of early acute care. As the swelling in the brain reduces, the impairments may recover on their own, usually within 3 weeks. Residual neurological deficits last longer than three weeks and can lead to lifelong disability.[1Functional daily living activities can be divided into two types namely basic activities of daily living (BADL) and instrumental

activities of daily living (IADL). 8 BADL includes basic self-care tasks, such as grooming, bathing, feeding and dressing, and other daily activities such as ambulating, transferring and communicating. The most prevalent disabling deficiency following a stroke is upper limb (UL) dysfunction. 5 For several months after a stroke, about 55 to 75 percent of stroke survivors were unable to use their damaged hand, and this residual arm dysfunction may induce dependency in performing functional daily living activities, resulting in a lower quality of life among survivor s.In light of the necessity of physical rehabilitation for stroke patients, an analytical evaluation has been created in which several therapies, such as functional electric stimulation, have been evaluated for their efficacy.

For the rehabilitation of upper extremity motor impairment, researchers used functional electrical stimulation (FES), noninvasive brain stimulation (NIBS), including transcranial direct current stimulation (t-DCS) and transcranial magnetic stimulation (t-MS), invasive epidural cortical stimulation, virtual reality (VR) rehabilitation, task-oriented therapy, robot-assisted training, tele rehabilitation, and cerebral plasticity. New therapeutic rehabilitation techniques, such as virtual reality, are also being researched.

The effects of robot-assisted (RA) virtual reality (VR) intervention on motor function (MF) and nerve function (NF) in patients with cerebral stroke (CS) were investigated in 60 patients with cerebral apoplexy hemiplegia at the convalescence stage (30 patients in each group). The CG underwent normal rehabilitation training (RT), while the EG had RT using robot VR technology. Upper limb (UL) function was assessed using the Brunnmstrom classification and the Fugl-meyer score.[2]

A thorough literature search was conducted to find articles that contained measures for assessing arm-hand skillful performance in stroke and cerebral palsy patients. Instruments were identified and classified as capacity, perceived performance, and actual performance. A second search was conducted to learn more about the content and psychometrics of the candidates.[3]

Twenty-six different rehabilitation treatment modalities were included, and the following search phrases were used to find them: Motor skill learning, constraint induced movement, mirror therapy, motor imagery, motor imitation, movement observation, transcutaneous electrical nerve stimulation, neuromuscular electrical stimulation, positional feedback, repetitive transcranial magnetic stimulation, transcranial direct current stimulation, deep brain stimulation, paired associa.[4]

Patients with hemiplegic stroke were randomly assigned to one of two groups: VFT or CTL. For eight weeks, sixteen patients in the VFT group had CR and VFT, while 15 patients in the CTL group received only CR. At baseline and the eighth week of the recovery training period, the Barthel Index (BI) was utilised to evaluate daily living activities. To test the recovery effect of the training therapies, researchers used the Fugl–Meyer assessment (FMA) scale, somatosensory evoked potential (SEP), and fMRI.. N9 and N20 latencies and amplitudes were measured. All patients in the VFT and CTL groups had their fMRIs done prior to recovery training. In addition, 2 months following treatment, 17 patients (9 in the VFT group and 8 in the CTL group) had fMRI for follow-up.5]

In this application, variables such joint angular accelerations and angular velocities must be obtained in order to close control loops aimed at achieving specified goals. These sensors should have certain features, such as a small size and a long battery life., the ability to extract a widerange of parameters from human motion, easy adaptability toan orthotic frame, suitable bandwidth and other preferredfeatures. These characteristics made Micro Electro-mechanical Systems (MEMS) inertial sensors attractive forthe rehabilitation robotics field [7]. The field of rehabilitation robotics [7-26] is a good fit for sensors. These sensors, such as accelerometers, gyroscopes, and magnetometers, can aggregate their measurements with the help of an Inertial Measurement Unit (IMU) to obtain kinematic data measures, such as acceleration, speed, position, and orientation. [6]

This randomised controlled experiment included twenty-five ischemic acute/subacute stroke patients. The experimental group 1 received low frequency (LF) rTMS to the unaffected side's primary motor cortex plus physical therapy (PT), which included activities to improve strength, flexibility, transfers, posture, balance, coordination, and activities of daily living, with a focus on upper limb movements; the experimental group 2 received the same protocol plus NMES to the hand extensor muscles; and the control group received only PT. The activity or inhibition of the afflicted and unaffected primary motor cortex was evaluated using a functional magnetic resonance imaging (fMRI) scan..[27-35]

The rehabilitation system used in this study was the FELXO-Arm1 system manufactured by Shanghai Electric GeniKIT Medical Science and Technology Co., Ltd. and comprises hardware and software componentFELXO-Arm1 has five degrees of freedom, which is uncommon in rehabilitative therapeutic devices, and is used to help stroke patients recover UL function. It has three passive joints in the horizontal plane and two active joints in the sagittal plane, comprising a motor and gear, which could provide additional assistance to patients undergoing rehabilitative training. The encoder and the torque sensor have different functions. Whereas the former is used for recording angular measurements of joints, the latter is utilized to obtain human-robot interactive torque measurement[36]

CONCLUSION

It's tough to design controlled trials to evaluate a health-care service like rehabilitation. 35 In a scenario where numerous variables are interacting, valid outcome criteria must be developed. Stroke rehabilitation should be performed in the most cost-In the most efficient and effective manner feasible, and to the biggest number of patients imaginable. Only one thing is undeniably and painfully evident from our current knowledge, or rather from its lack thereof: "Controlled clinical trials are necessary if the role of rehabilitation, its indications, and its contraindications are to be better understood."

REFERENCES

1. E. Chinnavan, Y. Priya, R. Ragupathy, and Y. C. Wah, "Effectiveness of Mirror Therapy on Upper Limb Motor Functions Among Hemiplegic Patients," Bangladesh J. Med. Sci., vol. 19, no. 2, pp. 208–213, Jan. 2020, doi: 10.3329/bjms.v19i2.44997.
2. S. Iqbal, M.-R. A. Butt, R. Adil, A.-U. Afridi, and U. Sarwar, "Frequency of primary headache disorders; a retrospective study," vol. 47, no. 1, p. 3, 2022.
3. R. J. Lemmens, A. A. Timmermans, Y. J. Janssen-Potten, R. J. Smeets, and H. A. Seelen, "Valid and reliable instruments for arm-hand assessment at ICF activity level in persons with hemiplegia: a systematic review," BMC Neurol., vol. 12, no. 1, p. 21, Apr. 2012, doi: 10.1186/1471-2377-12-21.
4. S. M. Hatem et al., "Rehabilitation of Motor Function after Stroke: A Multiple Systematic Review Focused on Techniques to Stimulate Upper Extremity Recovery," Front. Hum. Neurosci., vol. 10, 2016, Accessed: Apr. 21, 2022. [Online]. Available: https://www.frontiersin.org/article/10.3389/fnhum.2016.00442
5. M.-H. Zhu et al., "Visual feedback therapy for restoration of upper limb function of stroke patients," Int. J. Nurs. Sci., vol. 7, no. 2, pp. 170–178, Apr. 2020, doi: 10.1016/j.ijnss.2020.04.004.
6. C. Cifuentes, A. Braidot, L. Rodriguez, M. Frisoli, A. Santiago, and A. Frizera, "Development of a wearable ZigBee sensor system for upper limb rehabilitation robotics," 2012 4th IEEE RAS Amp EMBS Int. Conf. Biomed. Robot. Biomechatronics BioRob, 2012, Accessed: Apr. 21, 2022. [Online]. Available: https://www.academia.edu/16610464/Development_of_a_wearable_ZigBee_sensor_system_for_upper_limb_rehabilitation_robotics
7. J. Du et al., "Effects of Neuromuscular Electrical Stimulation Combined with Repetitive Transcranial Magnetic Stimulation on Upper Limb Motor Function Rehabilitation in Stroke Patients with Hemiplegia," Comput. Math. Methods Med., vol. 2022, p. e9455428, Jan. 2022, doi: 10.1155/2022/9455428.
8. Qu et al., "The Effect of Applying Robot-Assisted Task-Oriented Training Using Human-Robot Collaborative Interaction Force Control Technology on Upper Limb Function in Stroke Patients: Preliminary Findings," BioMed Res. Int., vol. 2021, p. e9916492, Jul. 2021, doi: 10.1155/2021/99164
9. M. L. Dombovy, B. A. Sandok, and J. R. Basford, "Rehabilitation for stroke: a review.," Stroke, vol. 17, no. 3, pp. 363–369, May 1986, doi: 10.1161/01.STR.17.3.363.
10. Suraj, Shaini. "Effectiveness of Cognitive Behavior TherapyonFamily Dynamics of Adolescents with Negative Life Event Induced Depressive Episodes." Bioscience Biotechnology Research Communications 14, no. 6 (June 15, 2021): 134–40. https://doi.org/10.21786/bbrc/14.6.31.
11. Suraj, Shaini, Anand Prakash, Pratibha Dawande, and Obaid Noman. "Exploring the Pathogenic Role of Stress in Inflammatory Bowel Disease and Its Management." Journal of Pharmaceutical Research International, July 28, 2021, 17–22. https://doi.org/10.9734/jpri/2021/v33i39A32135.
12. Syed, Tipu Khalil. "Flattening the Pandemic Curve of COVID-19 Explosion in India." Journal of Pharmaceutical Research International, July 31, 2021, 16–22. https://doi.org/10.9734/jpri/2021/v33i39B32175.
13. Takalkar, Shweta, Pratibha Deshmukh, Sweety Pasari, Priyanka Deshmukh, and Vivek Chakole. "Stress Induced Cardiomyopathy (Takotsubo) in a Post-Operative Pregnancy Induced Hypertension Patient Operated for Caesarean Section: A Case Report." Journal of Pharmaceutical Research International, July 27, 2021, 146–50. https://doi.org/10.9734/jpri/2021/v33i38B32109.
14. Taksande, Amar. "The Neurodevelopmental Outcome of Severe Neonatal Haemolytic and Non-Hemolytic Hyperbilirubinemia." The Journal of Pediatric Research 8, no. 2 (May 25, 2021): 214–15. https://doi.org/10.4274/jpr.galenos.2020.46762.
15. Taksande, Amar, Shruti Chaudhary, Abhilasha Singh Panwar, Aditi Jhamb, Rupesh Rao, Patel Zeeshan Jameel, Sachin Damke, and Revat Meshram. "Effect of Vibratory Therapy in Decreasing the Vaccination-Induced Pain in Infants: Randomized Controlled Study." Journal of Pharmaceutical Research International, June 8, 2021, 9–18. https://doi.org/10.9734/jpri/2021/v33i31A31659.
16. TAKSANDE, AMAR, Gnanvelu Injeti, Maithali Joshi, and Revat Meshram. "Sickle Cell Anemia Child Presented with Bell's Palsy: A Rare Case Report." International Journal of Pediatrics, no. Online First (August 2020). https://doi.org/10.22038/ijp.2020.50431.4014.
17. Taksande, Amar, Gnanvelu Injeti, Rewat Meshram, and Amol Lohakare. "A Rare Presentation of Infective Endocarditis in Child: Case Report." International Journal of Pediatrics, no. Online First (September 2020). https://doi.org/10.22038/ijp.2020.51166.4060.
18. Taksande, Amar, and Patel Zeeshan Jameel. "Critical Congenital Heart Disease in Neonates: A Review Article." Current Pediatric Reviews 17, no. 2 (August 23, 2021): 120–26. https://doi.org/10.2174/1573396317666210219162515.
19. Taksande, Amar, Patel Zeeshan Jameel, Divya Pujari, Bharati Taksande, and Revat Meshram. "Variation in Pulmonary Function Tests among Children with Sickle Cell Anemia: A Systematic Review and Meta-Analysis." Pan African Medical Journal 39 (2021). https://doi.org/10.11604/pamj.2021.39.140.28755.
20. Taksande, Amar, PatelZeeshan Jameel, Bharati Taksande, and Rewat Meshram. "Red Reflex Test Screening for Neonates: A Systematic Review and Meta Analysis." Indian Journal of Ophthalmology 69, no. 8 (2021): 1994. https://doi.org/10.4103/ijo.IJO_3632_20.
21. Taksande, Amar, and Rupesh Rao. "Early Detection of Central Nervous System Abnormalities by Neurosonography in Critically Ill Neonates." Iranian Journal of Neonatology IJN 12, no. 4 (October 2021). https://doi.org/10.22038/ijn.2021.55001.2020.
22. Taksande, Amar, Rupesh Rao, Sachin Yedve, Patel Zeeshan Jameel, and Revat Meshram. "Assessment of Different Technique of Eliciting the Planter Reflex in Term Neonates." Journal of Pharmaceutical Research International, June 8, 2021, 26–31. https://doi.org/10.9734/jpri/2021/v33i31A31661.
23. TAKSANDE, AMAR, Abhilasha Singh Panwar, Syed Athhar Saqqaf, and Rewat Meshram. "Atypical Presentation of Holt Oram Syndrome." International Journal of Pediatrics, no. Online First (December 2020). https://doi.org/10.22038/ijp.2020.53117.4209.
24. Taksande, Karuna, Krishnendu S., Nikhil Bhalerao, Jui Jadhav, Dnyanashree Wanjari, and Aditi Shatalwar. "Case Report – Accidental Epidural Catheter Breakage and Its Management." Journal of Pharmaceutical Research International, December 14, 2021, 1–5. https://doi.org/10.9734/jpri/2021/v33i57A33961.
25. Taksande, Vaishali Deoraoji, Priyanka Anil Ashtankar, Chetna Rajendra Bansod, Ashwini Vilas Bawane, Pratiksha Sankal Burchunde, Diksha Vinayak

Dudhe, and Madhavi Dharmpal Gawande. “To Assess the Job-Related Difficulties and Dissatisfaction of Asha Workers in Selected Rural Area.” Journal of Evolution of Medical and Dental Sciences 10, no. 2 (January 11, 2021): 98–101. https://doi.org/10.14260/jemds/2021/20.
26. Taksande, Vaishali, Deepti S. Shrivastava, and Sr. Tessy Sebastian. “Early Identification and Prevention of Postnatal Complications among the Postnatal Mothers by Using the ‘Postnatal Care Bundle.’” Journal of Pharmaceutical Research International, October 5, 2021, 175–81. https://doi.org/10.9734/jpri/2021/v33i45B32794.
27. Talwar, Dhruv, Sunil Kumar, Sourya Acharya, Vidyashree Hulkoti, and Akhilesh Annadatha. “Sirolimus in a Renal Transplant Recipient Infected With COVID-19: A Blessing in Disguise?” Cureus, August 11, 2021. https://doi.org/10.7759/cureus.17102.
28. Talwar, Dhruv, Sunil Kumar, Sourya Acharya, Shivam Khanna, and Vidyashree Hulkoti. “Managing COVID-19 Infection in a Young Acute Myeloid Leukemia Patient Successfully With Antiviral and Granulocyte Colony Stimulating Factor: Playing on a Sticky Wicket.” Cureus, July 23, 2021. https://doi.org/10.7759/cureus.16589.
29. Talwar, Dhruv, Sunil Kumar, Sourya Acharya, Shivam Khanna, and Vidyashree Hulkoti. “Paroxysmal Supraventricular Tachycardia and Cardiac Arrest: A Presentation of Pulmonary Embolism With Infarction as a Sequela of Long COVID Syndrome.” Cureus, October 7, 2021. https://doi.org/10.7759/cureus.18572.
30. Talwar, Dhruv, Sunil Kumar, Sourya Acharya, Sparsh Madaan, and Vidyashree Hulkoti. “Intractable Hiccups in a Young Male: Is It a Tell-Tale Sign of Pseudocyst of Pancreas?” Cureus, September 13, 2021. https://doi.org/10.7759/cureus.17951.
31. Tandale, Babasaheb V., Vijay P. Bondre, Gajanan N. Sapkal, Varanasi Gopalkrishna, Yogesh K. Gurav, R. Kondal Rao, Mohiuddin S. Qazi, et al. “Childhood Encephalitis Hospitalizations Associated with Virus Agents in Medium-Endemic States in India.” Journal of Clinical Virology 144 (November 2021): 104970. https://doi.org/10.1016/j.jcv.2021.104970.
32. Taneja, Anmol, Samarth Shukla, Sourya Acharya, and Sunita Vagha. “Intracranial Dermoid and Epidermoid Cysts: A Case Report.” JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH, 2021. https://doi.org/10.7860/JCDR/2021/50206.15590.
33. Tapadia, Shreya, Suresh Vasant Phatak, Harshith Gowda K.B, and Asish Pavanan. “Porencephalic Cyst in an Adult - A Rare Pathology.” Journal of Evolution of Medical and Dental Sciences 10, no. 12 (March 22, 2021): 918–19. https://doi.org/10.14260/jemds/2021/198.
34. Tawalare, Kalpana, Pradnya Dandekar, Priti Desai, and Kiran Tawalare. “Research Protocol for Assessment of Solitary and Combined Effect of Guduchi and Punarnava on Structural and Functional Changes of Ageing in Liver and Kidney in Wistar Rats.” Journal of Pharmaceutical Research International, June 2, 2021, 187–93. https://doi.org/10.9734/jpri/2021/v33i30A31630.
35. Tayawade, Akshay, and Akash More. “A Successful ART Treatment of Severe Asthenoteratozoospermia with Donor Sperms: A Case Study at Wardha Test Tube Baby Centre, India.” Journal of Pharmaceutical Research International, July 19, 2021, 64–69. https://doi.org/10.9734/jpri/2021/v33i37B32022.
36. Telang, Amit, Subramaniam Seshan Iyer, Kunal Saoji, and Vasant Gawande. “Treating of Joint Pain - Arthritis through YOGA.” Journal of Pharmaceutical Research International, July 21, 2021, 283–88. https://doi.org/10.9734/jpri/2021/v33i37B32051.