Comparison Of Motor Imagery Therapy And Stretch Reflex On Hand Grip Strength And Dynamic Balance Control In Post Stroke Patients

Ayesha Nawab[1], Sana Riaz[1], Alishba Mustansar[2], Saddiqa Qamar[3], Anas Ali[1], Ammara Abbas[4], Mohsina Naeem[3]

[1] *Riphah College of Rehabilitation and Allied Health Sciences, Lahore, Pakistan*

[2] *University Institute of Physical Therapy, Faculty of Allied Sciences, University of Lahore, Lahore, Pakistan*

[3] *University of Management and Technology, Lahore, Pakistan*

[4] *University of Health Sciences, Lahore, Pakistan*

ABSTRACT

Background: The stroke happens while the supply of blood to a sector of your mind is decreased or interrupted. Both grip strength in the troubled hand and dynamic balance control are affected in post stroke patients. **Objective:** To compare the effects of motor imagery therapy and stretch reflex on hand grip strength and dynamic balance control in post stroke patients. **Methods:** Randomized clinical trial was conducted on forty-six post stroke patients. All were randomly allocated to motor imagery group and stretch reflex group. Both groups were treated for three sessions per week for twelve consecutive weeks. Mini-Mental Scale Examination was used as a screening tool while Dynamometer and Berg Balance Scale were used to measure hand grip strength and dynamic balance, respectively. Values were recorded before treatment and after treatment. **Results:** Participants N=46 were randomly divided into two groups, Group A (motor imagery group) and Group B (stretch reflex group). Mean age and standard deviation of Group A were 55.57 and 4.39 respectively while that of Group B were 52.39 and 4.72 respectively. There was no significant difference between the mean values of pre and post right and left hand grip strengths with P-values 0.570 and 0.843 respectively. There was a significant difference between mean values of pre and post BBS score with P-value 0.002. Mean values of both techniques had no statistically significant difference at baseline in right and left hand grip strengths as P value= 0.472 and 0.452. Mean value of both techniques had statistically significant difference at baseline for BBS score as P value=0.001. Within group there was significant difference between mean values of both techniques for hand grip strengths and BBS score as P value was <0.05 in motor imagery and stretch reflex groups. **Conclusion**: Both techniques motor imagery therapy and stretch reflex technique showed better results in improving hand grip strength and dynamic balance control in post stroke patients. Both techniques were found to be effective. But stretch reflex was found to be more effective than motor imagery therapy for hand grip strength while motor imagery therapy was found to be more effective than stretch reflex for dynamic balance control.

Keywords: Motor imagery therapy, stretch reflex, hand grip strength, dynamic balance control, post stroke patients.

INTRODUCTION

The stroke happens while the supply of blood to a sector of your mind is decreased or interrupted, stopping mind tissue from gaining nutrients as well as oxygen. (Campbell et al., 2019) Cells in brain start to expire within minutes. (Katoozian, Tahan, Zoghi, & Bakhshayesh, 2018) The stroke is always a clinical emergency and instant remedy is important. Inconvenience in talking as well as expertise what is being said by others, hassle strolling, numbness as well as paralysis of muscles of face, leg and arm, difficulty noticing with either one or both the eyes and headache are included in some of the signs and symptoms. (Jhaveri Nikita & Kanase Suraj, 2020)

There are two critical reasons of stroke: an artery which is blocked (ischemic type of stroke) or a blood vessel that is leaking or bursting (hemorrhagic type of stroke). (Fugate et al., 2014) A few humans can have most effective a short-time period disruption of blood flow towards the mind, commonly called as a transient ischemic attack (TIA), which does no longer result in significant symptoms. Ischemic stroke is the most common type of stroke. (Caplan, 2016) This takes area whilst the vessels supplying blood to brain turn out to be blocked or narrowed ensuing in significantly limited flow of blood (ischemia). Whenever a blood vessel to your brain ruptures or leaks, hemorrhagic stroke takes vicinity. Many situations that have an effect on your blood vessels can bring about brain hemorrhages. (Nuis et al., 2012) Some elements associated with hemorrhagic stroke include: out of control hypertension, overtreatment with blood thinners (anticoagulants), trauma (inclusive of a motor automobile accident), bulges at vulnerable spots in walls of your blood vessels (aneurysms), deposits of protein in walls of blood vessels that bring about weak spot of the vessel wall and ischemic stroke leading to hemorrhage. The breach of an extraordinary coil of vessels of blood having thin walls (arterio-venous malformation) is a much less reason of oozing in the brain. (Gu et al., 2019)

A TIA once in a while called a ministroke is a short-term duration of signs much like the ones you will have in a stroke. A transient ischemic attack does not cause a permanent damage. (Johnston, 2002) They are due to a short-term reduction in delivery of blood to a section of your mind that can be of as short duration as 5 minutes. (Xia et al., 2019) A transient ischemic attack takes place while a particle or clot reduces or blocks the delivery of blood to a part of your nervous system just as that of ischemic type of stroke. (Sin, Kim, Cho, Cho, & Paik, 2018)

Motor imagery is described as the intellectual illustration of movement with no bodily movement. (Di Rienzo, Collet, Hoyek, & Guillot, 2014) Mental exercise is the voluntary practice session of imagery tasks or scenes, but motor imagery exercise refers in particular to the intellectual practice session of movement imagery contents with a particular purpose of enhancing movement overall performance. (Lotze & Halsband, 2006) Motor imagery is an intellectual manner where in a subject imago that she or he plays a motion without virtually appearing the motion and without even generating tension inside the muscles. It is a dynamic situation at some point of which the illustration of a particular motor movement is internally activated with no motion output. (Chholak et al., 2019)

Stretch reflex also known as myotatic reflex is a contraction of muscle as a result of stretching in a muscle. (Vieira, Silva, Melo, & Soares, 2017) The reflex features to keep the muscle at a regular duration. A stretch reflex may be a reflex consisting of a single synapse that offers automated adjustment of length of muscles of body, however that signal which enters the spinal cord originates from a variation in velocity of muscle or length. (Silva, Silva, Naves, Palomari, & Soares, 2017)

Electrotherapeutic agents like a heating pad is honestly taken into consideration as an accessory remedy to physiotherapy practice. Heating pad is hired earlier than utility of any healing technique.

(Kim, Cho, Park, & Kim, 2017) It creates the feeling of heat, remedy and rest and is particularly powerful for stretching. (Margrett et al., 2019)Thermotherapy or heating remedy is the only manner to relieve pain and lighten up the tender tissue through manner of dilating the blood vessels. The application time of ten to twenty minutes may be very powerful for subjects with stroke. (Monteiro et al., 2021)

Berg Balance Scale is normally used for measurement of dynamic balance. It is goal device for figuring out the patient's capability (or inability) to stabilize accurately for the duration of a hard and fast of predetermined tasks. (Praveen, Kumar, & Chauhan, 2018)

The current study had a rationale to assist the clinicians to provide evidence-based approach towards the application of intervention of motor imagery therapy and stretch reflex in the management of post stroke patients. It also had a significance to evaluate which treatment approach provided better outcomes for hand grip strength and dynamic balance control in the intervention regimen. So, that better results were achieved within a minimum treatment sessions and smaller number of patient visits.

Objectives of Study: To compare the effects of motor imagery therapy and stretch reflex on hand grip strength and dynamic balance control in post stroke patients.

Objectives of Study: H_0 There is no difference between motor imagery therapy and stretch reflex therapy on hand grip strength and dynamic balance control in post stroke patients. H_a There is a difference between motor imagery therapy and stretch reflex therapy on hand grip strength and dynamic balance control in post stroke patients.

METHODOLOGY

The study was randomized, single blinded (assessor was blind) clinical trial performed at Physiotherapy department of Jinnah Hospital Lahore. Ethical approval was taken from ethical committee of Riphah International University Lahore. Non-probability convenient sampling technique was used to gather the data. Sample size was 46 calculated by an online EPITOOL sample size calculator with 10% attrition rate. In this study total number of 50 patients (N=50) were assessed for eligibility criteria. 4 participants were excluded from study, among which 2 participants were not fulfilling the inclusion criteria and 2 participants declined to participate in study. 46 participants recruited in the study who were clinically diagnosed and met the inclusion criteria. So, total 46 patients (male: 25, female: 21) were eligible to meet the inclusion criteria and selected by lottery method of randomization process. Patients of age group between 40 to 60 years were enrolled. Both males and females of ischemic or hemorrhagic stroke in sub- acute stage. Stable condition, stable vital signs and without any progression of disease for over 48 hours. Normal cognitive function (MMSE 24-30), normal vision and capable of coping with the experiment were incorporated. Prior to treatment convention taking educated assent from patients and clarified treatment strategy were given. Members were rejected if there was any set of experiences of severe upper extremity pain or spasm, severe attention disorder, memory disorder, communication disorder, visual disturbances and aphasia. Participants were discarded in the events if they had MRI contraindication like metal present in the body, severe renal, liver, lung or cardiac disorder, impaired cognition or any experience of epilepsy or other neurological or psychiatric disorders. All members were distributed into 02 equal groups (Group A and Group B).

Members in Group-A were given motor imagery therapy nearby regular management, which joined hot pack for fifteen minutes. During proceeding of motor imagery subjects had been seated in a chair with eyes closed. Videos of regular hand grip and dynamic stability actions which consisted of wrist

fingers movements, elbow and shoulder flexion and extension in addition to ankle toe movements, hip and knee flexion and extension had been shown. Then participants needed to believe regular hand and lower extremity movements primarily based totally on visuals shown and the researcher asked the members to provide an explanation for the movements they had been imagining. This exercise became finished from an inner attitude with each visible and kinesthetic mode. With thirty minutes of session 3 days every week for 12 weeks, physical activities were targeted on particular hand grip strength and dynamic balance improvement and finishing of particular tasks. (Machado, Carregosa, Santos, Ribeiro, & Melo, 2019)

Subjects in Group-B were given stretch reflex nearby ordinary treatment, which fused with hot pack for fifteen minutes. All training sessions were organized and carried out by a trained physiotherapist. This group had a warm up protocol including stretch reflex exercises. The stretch reflex exercises were performed in a supine lying and prone lying positions. Two different stretch reflex positions had been alternated for both upper and lower extremities. (Ghasemi et al., 2018; Marques et al., 2019)

Complete treatment sessions were given to each patient with specific allotted technique and given 3 sessions per week for 3 consecutive months. At the end of 3 months, the stroke patients were assessed using Berg Balance Scale and a hand-held dynamometer. (López, Monge Pereira, Centeno, & Miangolarra Page, 2019) After collection of data, analysis was done by SPSS version 21. Normality of data was tested by using Shapiro-Wilk test. Both pre and post treatment values were evaluated in both groups.

DATA ANALYSIS AND RESULTS

Table-1 showed the distribution of gender in two groups. Motor Imagery therapy group showed that there were 23 participants 13 (56.5%) males and 10 (43.5%) females. Stretch reflex group showed that there were 23 participants 12 (52.2%) males and 11 (47.8%) females.

Table 1 Descriptive Statistics of Gender

Groups	Gender	Frequency	Percent
Motor Imagery Therapy	Male	13	56.5
	Female	10	43.5
	Total	23	100
Stretch Reflex	Male	12	52.2
	Female	11	47.8
	Total	23	100

Table 2 Descriptive statistics of Age

	N	Mean	Std. Deviation	Minimum	Maximum
Motor Imagery Therapy	23	55.57	4.399	47	60
Stretch Reflex	23	52.39	4.727	42	60

In Table 2, Descriptive Statistics described the mean age and standard deviation of both groups.

Mean age of Group A was 55.57 and standard deviation was 4.399 with minimum age of

participants 47 years and maximum age 60. The mean age of group B was 52.39 and standard deviation was 4.727 with minimum age of participants 42 years and maximum age 60.

Table 3 Test for Normality

Pre-Treatment Values	Skewness	Kurtosis	Shapiro- Wilk Test
Pre- treatment Right hand grip strength	0.48	1.01	0.56
Pre- treatment Left hand grip strength	0.583	0.428	0.82
Pre- treatment BBS Score	0.537	0.641	0.91

As shown in table the significance was > 0.05, which means that data was normally distributed. As value of Shapiro Wilk test was >0.05, the parametric tests were applied.

Table 4 Across the group comparison for Right hand grip strength (Independent t-test)

	Mean Difference	p value
Pre-Treatment Right hand grip strength	0.20	0.472
Post-Treatment Right hand grip strength	0.27	0.570

Table 4 showed that in across the group results regarding independent T test, Group A and Group B indicated that there was non-significant difference in value because P value was >0.05. Mean difference of pre-treatment right hand grip strength was 0.20 and mean difference of post treatment right hand grip strength was 0.27. So, both the techniques were equally effective.

Table 5 Across the group comparison for Left Hand Grip Strength (Independent t-test)

	Mean Difference	p value
Pre-Treatment Left hand grip strength	0.68261	0.452
Post-Treatment Left hand grip strength	0.36522	0.843

Table 5 showed that in across the group results regarding independent T test, Group A and Group B indicated that there was non-significant difference in value because P value was >0.05. Mean difference of pre-treatment left hand grip strength was 0.68261 and mean difference of post treatment left hand grip strength was 0.36522. So both the techniques were equally effective.

Table 6 Across the group comparison for BBS score (Independent t-test)

	Mean Difference	p value
Pre-Treatment BBS Score	5.26087	0.001
Post-Treatment BBS Score	0.52174	0.002

Table 6 showed that in across the group results regarding independent T test, Group A and Group B indicated that a significant difference was found in value because p value was <0.05. As the mean difference of pre-treatment BBS Score for Group A was 5.26087 which is greater than mean difference of post treatment BBS Score 0.52174. So, Group A (motor imagery) was more effective than Group B (stretch reflex).

Table 7 Within group comparison for Right hand grip strength (Paired sample t test)

	GROUP A (n=23)		GROUP B (n=23)	
	Mean diff. ±SD	P-value	Mean diff. ±SD	P-value
Pre and post Right hand grip strength	1.56087±0.86799	<0.05	2.03478±0.63433	<0.05

This table showed the Paired sample t test regarding before and after treatment for pre and post right hand grip strength. The mean and the standard deviation were 1.56087±0.86799 with p value less than 0.05 and 2.03478±0.63433 with p value <0.05 which was found to be significant for both group A and B, respectively. Since the mean difference of group B was greater than group A, it was found to be more effective than motor imagery.

Table 8 Within group comparison for Left Hand Grip Strength (Paired sample t test)

	GROUP A (n=23)		GROUP B (n=23)	
	Mean diff. ±SD	P-value	Mean diff. ±SD	P-value
Pre and post Left hand grip strength	1.45217±0.76388	<0.05	1.76957±0.63706	<0.05

This table showed the Paired sample t test regarding before and after treatment for pre and post left hand grip strength. The mean and the standard deviation were 1.45217±0.76388 with p value less than 0.05 and 1.76957±0.63706 with p value <0.05 which was found to be significant for both group A and B, respectively. Since the mean difference of group B was greater than group A, it was found to be more effective than motor imagery.

Table 9 Within group comparison for BBS Score (Paired sample t test)

	GROUP A (n=23)		GROUP B (n=23)	
	Mean diff. ±SD	P-value	Mean diff. ±SD	P-value
Pre and post BBS Score	21.30435±3.74694	<0.05	16.56522±2.33211	<0.05

This table showed the Paired sample t test regarding before and after treatment for pre and post BBS Score. The mean and the standard deviation were 21.30435±3.74694 with p value less than 0.05 and 16.56522±2.33211 with a p value <0.05 which was found to be significant for both group A and B, respectively. Since the mean difference of group, A was greater than group B, it was found to be more effective than stretch reflex.

DISCUSSION

The study aimed to explore and compare the two techniques i.e., motor imagery therapy and stretch reflex therapy on hand grip strength and dynamic balance control in post stroke patients. This preliminary contributed proof that motor imagery and stretch reflex techniques were convincing for the improving hand grip strength and dynamic balance control in post stroke patients. The post stroke patients had a noteworthy improvement in hand grip strength and dynamic balance control as a result of findings of current study.

Results of current study were likewise expected as those of Margrett et al (2019) who performed a study that compared mirror therapy and motor imagery on enhancing the gait among stroke sufferers. Seventy-one participants were taken whereas nine patients were not included in the criteria used for study. Out of 62 patients, each group contained thirty-one participants. A treatment of forty-five minutes was given to each of the two groups. First group performed exercise in the front of mirror and traditional treatment.

The other group consisted of intellectual illustration of motion with no body motion. Such sessions of treatment were done for consecutive six weeks including five days in a week for forty five minutes. (Margrett et al., 2019) The evaluation was done both before and after the session by gait tools used for proper functioning of gait. Descriptive statistical date was presented in the form of mean± standard deviation and percentages also represented graphically. Both the components gait parameters and 10 meters walk test for gait had shown differences in pre- and post- test values. But on comparing means of both groups, no difference was there as gait had been improved by both interventions in post stroke sufferers. Paired T test was used to check mean difference within groups while between groups differences were checked using independent T test. P<0.05 was considered as statistically significant for all statistical evaluation. The outcomes of the study revealed that there was improvement in gait in each group of stroke sufferers and there was no improvement across the group. Hence it showed that both techniques were similarly effective in improvement of gait among stroke sufferers. (Dickstein & Deutsch, 2007)

Current study corresponded to study of Machado et al, who in 2019 carried out a systematic review to find out the effectiveness of movement-based therapy together with motor imagery in improving movement limitations in upper extremity. The effectiveness of movement-based therapy along with motor imagery was put in comparison with movement-based therapy alone were present in RCTs. The consequences present were overall movement function and activities of daily living of upper extremity of stroke subjects. In RCTs that were present including one hundred four patients with methodological quality from slight to high. In all the studies that were conducted, there was greater effectiveness in movement function of upper extremity. (Machado et al., 2019) Only one study in which results of activities

of daily living of upper extremities were high and overall movement function was high was MI together with movement-based therapy in comparison to control group. The results of study showed that MI along with movement base therapy was a powerful tool in the improvement of movement function of upper extremity of stroke participants.

Likewise, another study was conducted by Khurana et al in 2019 to determine whether motor imagery together with conventional therapy found to be equal to or more effective than conventional alone for improvement of gait in stroke patients. Total 30 participants including both male and female who were previously diagnosed by Neurologist were recruited for the study. Subjects were selected as per convenient sampling and assigned to 2 groups. One was Group-A (experimental group) and the other was Group-B (control group). (Di Rienzo et al., 2014) In experimental category, subjects were given motor imagery and conventional therapy both while in group B, subjects were given conventional therapy alone. This group received Motor imagery (10-15 minutes) and conventional therapy (30-40 minutes) both and it was given in single session of 45-50 minutes. Therapy was given three times per week. Total duration of both therapies was for four weeks. For group B, intervention of conventional therapy alone was given for 30-40 minutes. Mean ± SD of pre-stride length for group A and group B were 65.03±15.08 and 64.46±17.14. Mean ± SD of post-stride length for both groups were 79±24.41 and 74.30±19.30. Regarding their age, no meaningful variations were noted between the groups. Motor imagery program was found to be effective when given with conventional therapy in improving gait in stroke patients. Results were found to be consistent with the results of current study. (PATIENT)

In 2021, Monteiro et al executed a meta-evaluation of randomized trials to assess results of motor imagery therapy as an integral resource on

the recovery of stroke sufferers. They performed a scientific overview in Pedro, Pubmed, Scopus, and Web of Science databases. Randomized controlled trials were incorporated in which motor imagery was used as an integral resource for the reclamation of sufferers troubled by stroke and whose outcomes were purposeful independence and motor function. 10 randomized controlled trials out of fourteen hundred and seventy-three researches were incorporated. In regard to interventions, motor imagery became related to electromyography, virtual reality, conventional rehabilitation, physical practice and structured progressive circuit class therapy. (Raza, Chowdhury, & Bhattacharyya, 2020) Fugl Meyer assessment and speed of gait were used to assess the overall performance of both upper and lower extremities respectively. The conclusion was made that when motor imagery therapy was used as a supplement to conventional techniques of recovery, it proved to be an effective and adequate therapy in the remedy of subjects after stroke. The outcomes of this study were consistent with the outcomes of current study.(Monteiro et al., 2021) In 2017, Kim J-H et al carried out a study to evaluate the effect of electromyogram triggered neuromuscular electrical stimulation and motor imagery training on the lower limb functions of stroke sufferers. 8 sufferers with paralysis of one side of body were recruited in this study. (Boulanger et al., 2018) The participants that were present in this study were either of right or left partial weakness, MMSE score >20, common rating on vividness of imagery tool less than 3 and potential to think. All subjects acquired motor imagery training and electromyogram triggered neuromuscular electrical stimulation every day for twenty minutes, five days in a week for four weeks. Two tests including ten meter walk test and timed up and go test were used to evaluate function of lower limb. (Allen & Barnett, 2011) After the results, it was concluded that MIT-EMG-NMES was an advance intervention for lower limb recuperation in stroke sufferers of hemiplegic type. Results were found to be consistent with the results of current study. (Kim et al., 2017)

CONCLUSION

The study results concluded that both techniques motor imagery therapy and stretch reflex technique showed better results in improving hand grip strength and dynamic balance control in post stroke patients. Both techniques were found to be effective. But stretch reflex was found to be more effective than motor imagery for hand grip strength while motor imagery was found to be more effective than stretch reflex for dynamic balance control.

REFERENCES

1. Allen, D., & Barnett, F. (2011). Reliability and validity of an electronic dynamometer for measuring grip strength. International Journal of Therapy and Rehabilitation, 18(5), 258-264.

2. Boulanger, J., Lindsay, M., Gubitz, G., Smith, E., Stotts, G., Foley, N., . . . Goddard, T. (2018). Canadian stroke best practice recommendations for acute stroke management: prehospital, emergency department, and acute inpatient stroke care, update 2018. International Journal of Stroke, 13(9), 949-984.

3. Campbell, B. C., De Silva, D. A., Macleod, M. R., Coutts, S. B., Schwamm, L. H., Davis, S. M., & Donnan, G. A. (2019). Ischaemic stroke. Nature Reviews Disease Primers, 5(1), 1-22.

4. Caplan, L. R. (2016). Caplan's stroke: Cambridge University Press.

5. Chholak, P., Niso, G., Maksimenko, V. A., Kurkin, S. A., Frolov, N. S., Pitsik, E. N., . . . Pisarchik, A. N. (2019). Visual and kinesthetic modes affect motor imagery

classification in untrained subjects. Scientific reports, 9(1), 1-12.

6. Di Rienzo, F., Collet, C., Hoyek, N., & Guillot, A. (2014). Impact of neurologic deficits on motor imagery: a systematic review of clinical evaluations. Neuropsychology review, 24(2), 116-147.

7. Dickstein, R., & Deutsch, J. E. (2007). Motor imagery in physical therapist practice. Physical therapy, 87(7), 942-953.

8. Fugate, J. E., Lyons, J. L., Thakur, K. T., Smith, B. R., Hedley-Whyte, E. T., & Mateen, F. J. (2014). Infectious causes of stroke. The Lancet Infectious Diseases, 14(9), 869-880.

9. Ghasemi, E., Khademi-Kalantari, K., Khalkhali-Zavieh, M., Rezasoltani, A., Ghasemi, M., Baghban, A. A., & Ghasemi, M. (2018). The effect of functional stretching exercises on neural and mechanical properties of the spastic medial gastrocnemius muscle in patients with chronic stroke: a randomized controlled trial. Journal of Stroke and Cerebrovascular Diseases, 27(7), 1733-1742.

10. Gu, X., Li, Y., Chen, S., Yang, X., Liu, F., Li, Y., . . . Chen, J. (2019). Association of lipids with ischemic and hemorrhagic stroke: a prospective cohort study among 267 500 Chinese. Stroke, 50(12), 3376-3384.

11. Jhaveri Nikita, H., & Kanase Suraj, B. (2020). Gender Wise Difference in Presenting Signs and Symptoms of Stroke: Observational Study. Indian Journal of Forensic Medicine & Toxicology, 14(3), 335.

12. Johnston, S. C. (2002). Transient ischemic attack. New England Journal of Medicine, 347(21), 1687-1692.

13. Katoozian, L., Tahan, N., Zoghi, M., & Bakhshayesh, B. (2018). The onset and frequency of spasticity after first ever stroke. Journal of the National Medical Association, 110(6), 547-552.

14. Kim, J.-H., Cho, Y.-S., Park, J.-S., & Kim, W.-J. (2017). Effect of motor imagery training and electromyogram-triggered neuromuscular electrical stimulation on lower extremity function in stroke patients: A pilot trial. Journal of physical therapy science, 29(11), 1931-1933.

15. López, N. D., Monge Pereira, E., Centeno, E. J., & Miangolarra Page, J. C. (2019). Motor imagery as a complementary technique for functional recovery after stroke: a systematic review. Topics in stroke rehabilitation, 26(8), 576-587.

16. Lotze, M., & Halsband, U. (2006). Motor imagery. Journal of Physiology-paris, 99(4-6), 386-395.

17. Machado, T. C., Carregosa, A. A., Santos, M. S., Ribeiro, N. M. d. S., & Melo, A. (2019). Efficacy of motor imagery additional to motor-based therapy in the recovery of motor function of the upper limb in post-stroke individuals: a systematic review. Topics in stroke rehabilitation, 26(7), 548-553.

18. Margrett, C. M., Thulasi, P. S., Prakash, P. K., Apparao, P., Swamy, G., & Chintada, B. T. (2019). A Comparative Study on Mirror Therapy and Motor Imagery on Improving Gait in Post Stroke Subjects. Executive Editor, 13(2), 23.

19. Marques, I. A., Silva, M. B., Silva, A. N., Luiz, L. M. D., Soares, A. B., & Naves, E. L. M. (2019). Measurement of post-stroke spasticity based on tonic stretch reflex threshold: implications of stretch velocity for clinical practice. Disability and rehabilitation, 41(2), 219-225.

20. Monteiro, K. B., dos Santos Cardoso, M., da Costa Cabral, V. R., Dos Santos, A. O. B., da Silva, P. S., de Castro, J. B. P., & de Souza Vale, R. G. (2021). Effects of Motor Imagery as a Complementary Resource on the Rehabilitation of Stroke Patients: A Meta-Analysis of Randomized Trials. Journal of Stroke and Cerebrovascular Diseases, 30(8), 105876.

21. Nuis, R.-J., Van Mieghem, N. M., Schultz, C. J., Moelker, A., Van Der Boon, R. M., Van Geuns, R. J., . . . Van Domburg, R. T. (2012). Frequency and causes of stroke during or after transcatheter aortic valve implantation. The American journal of cardiology, 109(11), 1637-1643.

22. PATIENT, I. O. G. I. S. MOTOR IMAGERY TOGETHER WITH CONVENTIONAL THERAPY WILL BE EQUAL TO OR MORE EFFECTIVE THAN CONVENTIONAL ALONE FOR IMPROVEMENT OF GAIT IN STROKE PATIENT.

23. Praveen, S., Kumar, N., & Chauhan, A. (2018). Combined Effect of Mirror Therapy and Thermal Stimulation on Upper Extremity Motor Functions in Post Stroke Hemiparetic Subjects. Physiotherapy and Occupational Therapy Journal, 11(2), 47-52.

24. Raza, H., Chowdhury, A., & Bhattacharyya, S. (2020). Deep learning based prediction of EEG motor imagery of stroke patients' for neuro-rehabilitation application. Paper presented at the 2020 International Joint Conference on Neural Networks (IJCNN).

25. Silva, M. B., Silva, A. N., Naves, E. L. M., Palomari, E. T., & Soares, A. B. (2017). An improved approach for measuring the tonic stretch reflex response of spastic muscles. Computers in biology and medicine, 80, 166-174.

26. Sin, M., Kim, W.-S., Cho, K., Cho, S., & Paik, N.-J. (2018). Improving the test-retest and inter-rater reliability for stretch reflex measurements using an isokinetic device in stroke patients with mild to moderate elbow spasticity. Journal of Electromyography and Kinesiology, 39, 120-127.

27. Vieira, D., Silva, M. B., Melo, M. C., & Soares, A. B. (2017). Effect of myofeedback on the threshold of the stretch reflex response of post-stroke spastic patients. Disability and rehabilitation, 39(5), 458-467.

28. Xia, X., Yue, W., Chao, B., Li, M., Cao, L., Wang, L., . . . Li, X. (2019). Prevalence and risk factors of stroke in the elderly in Northern China: data from the National Stroke Screening Survey. Journal of neurology, 266(6), 1449-1458.