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Effect of Sensory Re-Education to Improve Hand Function in Stroke Patients: A Case Series

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Abstract: ***Introduction: A stroke is marked by a sudden onset of neurological impairment caused by brain artery damage. Vascular damage in the brain can be caused by abrupt changes in blood pressure and an oxygen deficit that kills brain cells. Eighty percent of stroke cases are caused by ischemia. Over 15 million people worldwide suffer a stroke each year, and five million of them are left permanently disabled. Abnormalities that affect the upper extremities often include muscle weakness or paralysis, poor muscle coordination, incorrect proprioception and superficial feeling, and pain that can restrict range of motion and ultimately lead to an upper extremity deformity. Objective: The purpose of this study was to assess how well sensory training improved hand function in stroke patients Methodology: A case series was conducted on department of Neuro physiotherapy, Dr. A.P.J Abdul kalam college of physiotherapy, Loni 5stroke patients were assessed between March 2024 to September 2024. Research ethical approval was obtained from institutional ethical committee of pravara institute of medical science Loni. four – week treatment period 5 days per week treatment protocol were given to patient. Results: After 5 participants completed the study, a statistically significant improvement was observed in all assessed variables: stroke impact scale, action research arm test, Graded and redefined assessment of strength, sensibility and prehension Based on the statistical analysis the result of the study shows that there is statistically significant difference between pre-test and post-test values. P value <0. 001.Conclusion: Post-stroke sensory impairment is a typical issue. The patient's inability to execute daily living activities is a result of sensory loss. The upper limb significantly recovered following the sensory re-education.***

Keywords: Stroke rehabilitation, Sensory training, Post-stroke recovery, Upper extremity function, Sensory re-education, Stroke impact scale, Action research arm test, Strength assessment, Sensory impairment, Neurophysiotherapy, Hand function, Stroke-induced disability

1. Introduction

dysfunction brought on by artery damage in the brain. Sudden variations in blood pressure and an oxygen shortage that results in the death of brain cells can cause vascular injury in the brain. Ischaemia is the cause of stroke in 80% of instances. Every year, 15 million individuals worldwide experience a stroke, and five million become permanently disabled. [1]

After three months, almost 80% of stroke survivors experience motor disability, particularly in the upper limb. ADLs, or activities of daily living, are dependent on between 23% and 53% of the population. The upper extremities are frequently affected by abnormalities such as weakness or paralysis of the muscles, poor coordination of the muscles, aberrant proprioception and superficial sensation, and pain that can limit range of motion and eventually result in an upper extremity deformity.[2]

A stroke is a neurological condition caused by injury to the central nervous system (CNS), which can be brought on by an embolism or thrombus in the cerebral artery or by an arterial rupture or haemorrhage [12]. Nervous tissue frequently becomes necrotic when oxygen levels are low or absent in brain cells. The brain is a fascinating and intricate anatomical and functional region of neurology.[3]

A stroke occurs when there is insufficient oxygen reaching the brain, causing damage to brain cells. A cerebral haemorrhage occurs when blood vessels burst from excessive blood pressure, while an ischaemic stroke occurs when brain cells are damaged by a blood clot in a blood vessel. A little over 80% of strokes are ischaemic, while only 20% are non-ischemic.[10]

An occupational therapist with the necessary training and experience can administer a program called sensory re-training that includes joint movement exercises and both motor and sensory stimulation using various textures, shapes, objects, and stimulus. The treatment follows a set protocol.[16] The patient can regain their sense of touch, form, object, and joint sense that they may have lost or compromised following a stroke by using sensory retraining.[16]

The location of the lesion can affect the clinical characteristics of a stroke. The deficits will be severe when there is a big brain lesion. Reduced motor control, sensory impairment, cognitive impairment, communication difficulties, and decreased functional capacity are among the frequent stroke deficits [9] The rehabilitation of motor control is delayed in cases of significant sensory impairment. Due to sensory impairment, the upper limb's function is considerably diminished, which is why therapies are needed.[15]

After a stroke, recovery is extremely difficult for people to understand. The severity of the infarction, age, pre-stroke state, early therapy, and other factors are among the numerous variables that affect stroke recovery [6]. Individual differences exist in the recovery from stroke, with certain aspects of rehabilitation happening on their own. It happens occasionally that the recuperation takes two or three months. The intrinsic as well as functional recovery happens within six months. A longer recovery period is required for stroke patients who are first seriously handicapped.[7]

Following a stroke, recovery appears to be correlated with sensory function. Sensory issues following a stroke are most prevalent. To apply the sensory treatment for a better recovery following a stroke, it is first necessary to quantify the sensory impairment.[11] We are conscious of the fact that sensation is an active process and that senses play a vital role in a person's everyday existence. The person receives the sensory stimuli that are associated with them [8].

The function of their upper limbs was diminished in stroke survivors. Long-term impairment to upper limb function persists instead of lower extremity healing. For the majority of stroke survivors, upper limb function is impaired for the duration of their lives. [12] According to a study, approximately 32% of stroke survivors experienced substantial upper limb damage following their stroke, necessitating extended rehabilitation or a permanent loss of function in their affected upper limb. When there is a reduction in sensory function, it takes longer to regain upper limb function and less participation in everyday activities. [5] Sometimes they don't realise this sensory process is happening until they are not focused on sensation. For example, when they are dressed, their skin feels different than usual, but when he focusses on this, he becomes aware of it. Therefore, attention to sensory processing is necessary while expecting a stroke recovery.[16]

Stroke survivors experience 60% of the population with sensory impairment. Most of the patient's impairments following a cerebrovascular accident (stroke) were related to tactile and proprioceptive discriminating. Recent research has indicated that 85% of stroke survivors experience sensory impairment in their upper limb [.2]

It is also stated that individuals who have post-stroke sensory impairments of the UL have trouble with a variety of everyday tasks, including personal care tasks like showering, dressing, and tying shoelaces, household tasks like cooking, holding objects, and using cutlery, as well as leisure activities [14]. Limitations on the activities could then result in limitations on social roles and perceived involvement. Notwithstanding these issues, stroke rehabilitation of the upper limb (UL) pays scant attention to sensory problems; as therefore, there is a pressing need to provide more effective UL rehabilitation methods for people who have sensorimotor impairments following stroke [13]

Sensory re-training is a treatment technique program by different types of sensory stimulation to the patient with sensory impairment. Through this sensory retraining program, it tries to recover the functional sensory ability in the damaged area and learn adaptive functioning [4]

2. Methodology

A case series was conducted on department of Neuro physiotherapy, Dr. A.P.J Abdul kalam college of physiotherapy, Loni 5stroke patients were assessed between March 2024 to September 2024. Research ethical approval was obtained from institutional ethical committee of pravara institute of medical science Loni. four – week treatment period 5 days per week treatment protocol were given to patient.

Inclusion

1) Age between 18- 65years
2) Gender both male and female
3) Incomplete sensory function
4) Ability to understand oral and written information
5) Middle cerebral arterie
6) Acute and subacute

Exclusion

1) Other neurological conditions (Parkinson's disease, multiple sclerosis etc.)
2) Participants not willing to participate
3) Chronic operated case

Description of Outcome

1) Research arm test

The Action Research Arm Test (ARAT) is a 19-item observational measure used to assess upper extremity performance (coordination, dexterity and functioning) in stroke recovery. The ARAT was originally described by Lyle in 1981 as a modified version of the Upper Extremity Function Test and was used to examine upper limb functional recovery post damage to the cortex. Items comprising the ARAT are categorized into four subscales (grasp, grip, pinch and gross movement) and arranged in order of decreasing difficulty, with the most difficult task examined first, followed by the least difficult. Task performance is rated on a 4-point scale, ranging from 0 (no movement) to 3 (movement performed normally)

2) Stroke impact scale the stroke Impact Scale (SIS) is a stroke-specific, self-report, health status measure. It was designed to assess multidimensional stroke outcomes, including strength, hand function activities of Daily Living / Instrumental activities of Daily Living (ADL/IADL), mobility, communication, emotion, memory and thinking, and participation. The SIS is a patient-based, self-report questionnaire. Each item is rated using a 5-3point. The patient rates his/her difficulty completing each item,
1 = an inability to complete the item
5 = no difficulty experienced at all.

3) GRASSP Scale

the GRASSP (Graded Redefined Assessment of Strength, Sensibility, and Prehension) scale is a specialized clinical tool used to evaluate upper limb function in individuals This comprehensive assessment measures motor strength, sensory function, and prehension (grasp ability) to provide a detailed understanding of hand and arm capabilities. By integrating both objective and subjective elements, GRASSP captures the intricate impacts of SCI on upper limb functionality. Its multidimensional approach helps clinicians track recovery, plan rehabilitation strategies, and assess the effectiveness of interventions. he GRASSP scale is invaluable for tailoring patient-centered therapeutic goals

Intervention

a) Sensory re-education

The sensory protocol comprised sensory relearning in combination with task-specific training. The training was performed in small groups of two participants, 1 h/session, twice a week for 5 weeks. The training protocol was

standardized and comprised touch discrimination of smooth and rough surfaces and materials; identification of objects of different sizes and shapes; tactile object recognition; and exercises for proprioception. Exercises were calibrated via vision and by using the unaffected hand. The task-specific exercises included fine and gross motor training in various activities. To enhance learning, all exercises were repetitive. Feedback in terms of verbal and manual guidance on the performance was provided from the therapist. They were also encouraged to use the affected UL as much as possible in meaningful daily activities and to reflect on the touch experiences. Overall, the training was individualized depending on the participants' sensorimotor capacity and goals.

Table 1.1: Sensory reeducation Exercise for hand function

S No	Sensory Re-education	Material	Hand function	Frequency
1	Texture	Rough to soft texture which is wrapped around different shape object	Sand paper velvet clothe cotton Different paper texture smiley ball Buttoning and unbuttoning	10min 10 reps 2sets
2	Object identification	Wooden block smiley ball Circular object marbles	Hold and identify object	10 min 10 reps 2 sets
3	Temperature	Hot water and cold [ice cubes]	Cold spoon cold bottle Ice cube Hot water bottle Warm cloth	10 min 10 reps 2 sets
4	Touch localization	Temperature Texture	Rough and soft cloth and location	10 min 10 reps 2 sets
5	Proprioception	Mirror	Perform pain free movement with both hands	10 min 10 reps 2 sets

1.4.2 Description of the patient

Table 1.2: Description of symptoms

Sr.no	Age	Gender	Affected side	Duration	Hand function affected
1	57	Male	Right	2Month	Right
2	32	Male	Right	6Month	Right
3	41	Male	Left	7Month	Left
4	45	Female	Right	2.5Month	Right
5	37	Female	Left	1 year	Left

b) Statistical Analysis

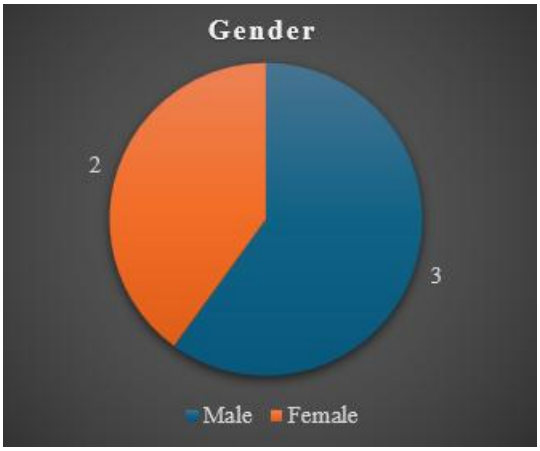
The data obtained from the assessments were analysed using the IBM SPSS 20.0 software program. Mean (X) and standard deviation (SD) were used for quantitative data, and qualitative data. The data's compliance to normal distribution was evaluated by the parametric test one sample t test. however, The Wilcoxon signed ranks, Mann-Whitney U, and chi square non-parametric tests were used. The paired-t test was used before and after treatment for intra-group comparisons of the collected data. The level of statistical significance was accepted as $p<0.001$

3. Result

A total of 5 individuals participated in this study (Fig. 1). As demonstrated in Table 2, the mean of age, height, and weight of the participants were calculated. Mean age and SD of the participant was 44.2±20.94, 2 Female and 3 Male were participated in this study, Mean of Height (167.45±5.06), Weight (59.5±7.67) and BMI was 26.72±2.49.

Table 1.3: Demographic Details

Variable	3Score
Age	42.40±9.4
Gender	Male-3 Female-2
Height	167.45±5.06
Weight	59.5±7.67
BMI	26.72±2.49



Graph 1.1: Gender wise classification of Male and Female

Table 1.4: Comparison of mean Pre and Post score of the all the outcome

Variable	Pre-Score	Post Score	P value
Stroke Impact Scale	39.6±12.34	72 ± 6.9	0.0002
Action research arm test	14.6±8.5	52.6±4.03	<0.0001
GRASSP	69.6±6.16	105.08±6.61	<0.0001

Graph 1.2: Comparison of Mean of Pre and Post score of the all the outcome

Stroke impact scale mean score for pre-test was 39.6±12.34 and post test score mean was72 ± 6.9which shows significant improvement. Action research arm test for pre-test was 14.6±8.5 and post test score 52.6±4.03 which shows

significant improvement and Graded and Redefined Assessment of Strength, Sensibility, and Prehension [GRASSP] pre-test was 69.6±6.16 and post-test 105.08±6.61 which shows significant improvement

4. Discussion

A stroke is a neurological condition brought on by injury to the central nervous system (CNS), which can be caused by an embolism or thrombus in the cerebral artery, haemorrhage in the artery, or rupture of the nerve. The study's goal was to find out whether or not stroke survivors with sensory impairment responded to sensory retraining when combined with standard occupational treatment when compared to just standard occupational therapy.

The investigator observed notable improvements in tactile perception, proprioception, and stereognosis in the upper limbs, as well as an improvement in upper limb function as well as the level of involvement with activities of daily living or self-care. The linked factors that affect the efficiency of treatment were also discovered by the researcher. Stereognosis, proprioception, and tactile feeling assessments were all statistically significant. The scores for functional activities and function of the upper limb were significantly statistically significant.

New insights and understanding into the potential and effectiveness of sensory retraining in conjunction with traditional therapy on functioning of the upper limb following a stroke have been added by the final results of sensory training. The findings also provide insight into how the sensory re-training treatment is delivered using local resources and provide insight into sensation and training outcomes.

According to Lima et al. (2015) and Islam et al. (2013), stroke remains one of the leading causes of disability and a significant source of morbidity and mortality. Following a stroke, recovery appears to be correlated with sensory function. Sensory issues following a stroke are most prevalent. It has been demonstrated that approximately 60% of stroke survivors suffer from sensory impairment (Daniela et al., 2010). Sensory disorders is most prevalent in stroke patients, and stroke survivors also benefit greatly from sensory retraining. The usefulness of sensory retraining for stroke survivors, nevertheless, was not previously studied. Sensation has played an important part in stroke recovery. The sensory state should be evaluated, the treatment strategy should be prioritised, and it should be regularly assessed. The functional result of the patient is dependent on both motor control and sensory processing. For a reliable and valid assessment of the sensory status of the patient with sensory impairment, a standardized sensory scale must be used. Following a stroke, sensory issues are linked to the outcome. (L. A. Connell, 2007)

Five participants—three men and two females—had been chosen for this study based on both inclusive and exclusive criteria. Reintroducing the senses is the interventional strategy. Together with task-specific training, the sensory protocol encompassed sensory relearning. The training was carried out twice a week for five weeks in small groups of just two individuals, lasting a single hour each session

5. Conclusion

Sensory re-education can play a significant role in improving hand function in stroke patients by addressing sensory deficits that often impair fine motor skills and functional independence. The findings from this case series suggest that targeted sensory re-education interventions, including activities focused on sensory discrimination, tactile localization, and proprioception, can enhance both sensory and motor recovery. This improvement is likely due to neural plasticity, which allows the brain to reorganize and adapt following injury. However, the results highlight the need for individualized therapy programs tailored to the severity and specific sensory deficits of each patient.

6. Clinical Implications

The findings from this case series highlight the importance of incorporating sensory re-education into the rehabilitation of stroke patients with hand function impairments. Sensory re-education can enhance sensory-motor integration, leading to improvements in both sensory perception and motor control. Clinicians should consider early implementation of sensory re-education interventions to capitalize on the brain's neuroplasticity and optimize functional recovery. Furthermore, combining sensory re-education with other rehabilitation approaches, such as motor training and task-specific activities, may yield synergistic benefits. Personalized therapy plans tailored to the individual's sensory deficits and functional goals are essential to maximize effectiveness. These results also emphasize the need for continued research to establish standardized protocols and further validate the role of sensory re-education in improving hand function and overall quality of life in stroke patients.

7. Limitations and Future Directions

This case series has several limitations that should be acknowledged. The small sample size restricts the generalizability of the findings, and the lack of a control group makes it challenging to isolate the effects of sensory re-education from other concurrent therapies. Additionally, variations in stroke severity, lesion location, and individual patient characteristics may have influenced the outcomes, highlighting the need for more standardized protocols. The study also relied heavily on subjective outcome measures, which may introduce bias. Future research should focus on larger, randomized controlled trials to provide more robust evidence for the efficacy of sensory re-education in stroke rehabilitation. Advanced imaging techniques could be utilized to explore neuroplastic changes associated with these interventions. Furthermore, investigating the long-term effects of sensory re-education and its integration with other therapeutic modalities could offer valuable insights for optimizing stroke rehabilitation strategies.

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