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Original Article

Predictive Validity Of Brunnstrom Stages Of Recovery Of Hand For Functional Activities Measured By ICF Codes And Sollerman Hand Function Test In Persons With Stroke- A Cross-Sectional Analytical Study

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ABSTRACT

Introduction: The Brunnstrom Recovery Stages (BRS) are widely used to assess motor recovery of the hand; however, evidence regarding their ability to predict functional hand performance remains limited. Linking motor recovery stages with activity-level outcomes aligned with the International Classification of Functioning (ICF) framework and performance-based tests is essential for clinical decision-making. Purpose of the Study: To determine the predictive validity of BRS hand for functional activities measured by ICF hand activity codes and the Sollerman Hand Function Test (SHFT) in patients with stroke. Methods: A cross-sectional analytical study was conducted on 48 subacute and chronic stroke patients selected using convenient sampling from a tertiary healthcare center. Hand motor recovery was assessed using Brunnstrom Recovery Stages for hand. Functional hand performance was evaluated using ICF activity qualifiers (d4400–d4403: picking up, grasping, manipulating, releasing) and SHFT. Assessments were performed at baseline, 2 weeks, and 4 weeks. Descriptive statistics summarized demographic data. Pearson and Spearman correlation coefficients were used to analyze relationships between BRS-hand and functional measures. Results: Strong positive correlations were observed between BRS-hand and SHFT ($r = 0.91–0.92$). Strong negative correlations were found between BRS-hand and ICF hand activity codes ($r = –0.87$ to $–0.92$), reflecting better function with higher BRS stages. Conclusion: Brunnstrom Recovery Stages of hand demonstrate strong predictive validity for functional hand performance measured by ICF activity codes and SHFT. BRS-hand can serve as a simple and clinically useful indicator of functional hand recovery in stroke rehabilitation.

Keywords: Hand function, Prediction, Brunnstrom stage, ICF code, Sollerman hand function test.

INTRODUCTION

Stroke typically leads in upper limb motor deficits that severely restrict independence and quality of life, making it one of the top causes of long-term disability globally[1]. Because the hand is necessary for object handling, self-care activities, communication, and social role participation, hand dysfunction is one of these impairments that is most incapacitating[2]. Despite the possibility of proximal upper limb recovery, functional hand usage is frequently not fully restored, and many people continue to exhibit deficiencies in fine motor coordination, gripping, and releasing[3].

Neuroplastic remodeling and the progressive restoration of voluntary control are hallmarks of motor recovery following a stroke[4]. The Brunnstrom Recovery phases (BRS), which divide motor return into six successive phases ranging from flaccidity to near-normal movement, are frequently used in clinical settings to characterize this recovery[5]. The shift from reflexive mass grasp patterns to individual finger movements and sophisticated motor control is particularly seen in the BRS-hand component. BRS is still often employed in clinical neurorehabilitation settings, especially in settings with limited resources, because to its simplicity, low equipment requirements, and ease of application[6].

However, BRS focuses on motor control patterns rather than performance on real-world tasks, hence measuring recovery largely at the impairment level. The International Classification of Functioning,

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Disability, and Health (ICF) and other contemporary rehabilitation frameworks place more emphasis on activity and involvement evaluation than just disability[7]. Activities like picking up, grasping manipulating, and releasing things are included in the ICF model's category for hand use (d440). These areas have more therapeutic significance for patients since they directly indicate functional independence.

Performance-based functional evaluations, like the Sollerman Hand Function Test (SHFT), use task-oriented, standardized tasks that simulate the demands of everyday life to measure hand function. SHFT has proven validity and reliability in neurological populations and offers objective measurement of hand function[8]. The predictive and therapeutic decision-making utility of a basic motor recovery scale like the BRS would be increased by connecting it to performance-based functional measures like the SHFT and ICF activity criteria.

Although BRS is widely used, there is limited evidence that it can predict functional hand performance at the activity level[9]. Therapists who use staging systems to define objectives, predict recovery trajectories, and create task-specific therapies must comprehend this link. The ongoing use of BRS as a rapid, clinically significant measure of functional hand recovery would be supported by establishing predictive validity.

Therefore, the present study aimed to determine the predictive validity of Brunnstrom Recovery Stages of hand function for functional hand activities measured using ICF hand activity codes and the Sollerman Hand Function Test in patients with stroke.

MATERIALS AND METHODS

Ethics: Approval from Institutional Ethics Committee. Obtained informed consent from participants.

Study design: Cross- sectional study

Participants: Forty-eight individuals with subacute or chronic stroke were recruited from a tertiary healthcare center using convenient sampling.

Inclusion Criteria: Patient's age of 20 years and above, both males and females, first ever stroke either Ischemic or Hemorrhagic type, those who were able to sit with or without support for at least 30 min and with MMSE score > 24.

Exclusion Criteria: Patients with any musculoskeletal problem related to wrist and hand (eg. Recent fracture and sprain) or any cardiorespiratory condition, who are not willing to participate, Patients undergoing other treatment for hand function (e.g. Acupuncture therapy and Anti-spasmodic medications) or received Botulinum toxin injections within 3 months and those with histories of other neurological diseases such as dementia and peripheral polyneuropathy.

Measurement tools: Brunnstrom recovery stages for hand, ICF Codes for Hand, Sollerman Hand Function Test

Variables:

Independent- Age, Gender, Hand Function, Duration of Stroke, Brunnstrom hand recovery stage

Dependent- ICF Codes for Hand, Sollerman Hand Function Test

Participants were assessed for inclusion and exclusion criteria after institutional ethics committee clearance. The study's methods, hazards, and suggested advantages were communicated to willing participants in a manner that they could understand. The participants gave their informed consent and were given an explanation of the entire process in their native tongue. Information on the stroke's history and demographics were gathered. A baseline evaluation was conducted in a medical facility. The Sollerman Hand Function Test, ICF Codes for the hand, and Brunnstrom phases of hand recovery were used to evaluate voluntary hand control. Using the same measuring instruments, follow-up evaluations were after two and four weeks.

Statistical analysis: Descriptive statistics summarized demographics. Pearson and Spearman correlation coefficients examined relationships between BRS-hand and SHFT and ICF codes.

RESULTS

Characteristics	Mean ± SD	Percentage (Number)
Age	61.22 ± 12.25 years	-
Gender- Male Female	31 17	64.5 35.5
Hand Dominance- Right Left	44 4	91.6 8.4
Duration	42.6 ± 71.06 weeks	-
Stage- Subacute Chronic	30 18	62.5 37.5
Affected side- Right Left	19 29	39.5 60.5
Type- Ischemic Hemorrhagic	30 18	62.5 37.5

Table 1. Demographic Data

Measurement tools		Mean± SD		
		Baseline	After 2 weeks	After 4 weeks
Brunnstrom Recovery Stage of Hand		3.56± 1.92	3.77± 1.87	4.02± 1.88
ICF Codes:	d4400 Picking up	2.02± 1.70	2± 1.68	1.89± 1.62
	d4401Grasping	1.95± 1.66	1.91± 1.64	1.83± 1.60
	d4402Manipulating	2.5± 1.50	2.37± 1.64	2.20± 1.68
	d4403Releasing	2.02± 1.75	2± 1.73	1.82± 1.67
Sollerman Hand Function Test		41.70± 31.89	43.33± 31.89	45.29± 31.89

Table 2. Mean and SD for measurement tools

Independent Variable	Dependent Variable	r value		
		Baseline	After 2 weeks	After 4 weeks
Brunnstrom Recovery Stage of Hand	Sollerman Hand Function Test	0.92	0.91	0.92

Table 3. Correlation between Brunnstrom recovery stage of Hand and Sollerman Hand Function Test

Independent Variable	Dependent Variable	r value		
		Baseline	After 2 weeks	After 4 weeks
	ICF Code: Picking up	-0.91	-0.88	-0.92

Brunnstrom Recovery Stage of Hand	Grasping	-0.90	-0.89	-0.91
	Manipulating	-0.90	-0.89	-0.90
	Releasing	-0.91	-0.87	-0.90

Table 4. Correlation between Brunnstrom recovery stage of Hand and ICF codes for Hand

DISCUSSION

The present study examined the predictive validity of the Brunnstrom Recovery Stages of Hand (BRS-hand) for functional hand performance measured through ICF activity qualifiers and the Sollerman Hand Function Test (SHFT) in individuals with stroke. According to demographic data, the research population's mean age was 61.22 ± 12.25 years, which is consistent with the worldwide epidemiological trend that shows a higher prevalence of stroke in those over 60[1]. Males were more prevalent (64.5%), which is in line with research that indicates men are somewhat more likely than women to have strokes[10]. Ischemic stroke (62.5%) is found to be more prevalent than haemorrhagic stroke (37.5%), as per the evidences available in the literature[11,12]. Left sided hemiparesis, that is right brain lesion was found to be present more than right sided hemiparesis (left brain lesion), showing the similar results as in the study done by various authors.[13,14,15]

(Table.1)

According to the study, the hand's mean BRS increased gradually from 3.56 at baseline to 4.02 after four weeks, indicating both neurological and functional improvement. Simultaneously, SHFT scores showed an incremental improvement from 41.70 at baseline to 45.29 at the four-week assessment. Over the course of four weeks, there was a decline in scores for ICF-based hand activity codes (d4400–d4403), which encompass tasks including picking up, gripping, manipulating, and releasing. This represents an increase in hand functionality since lower ICF qualification scores are indicative of improved function (WHO, 2001). The pace of development, however, differed depending on the activity; "manipulating" and "releasing" made somewhat less progress than "picking up" and "grasping." (Table.2)

The most important result was the strong positive correlation between BRS-hand and SHFT scores (r = 0.91–0.92). This indicates that as patients progressed through Brunnstrom stages, their ability to perform task-oriented, real-world hand activities improved proportionately. Additionally, the strong negative correlations between BRS-hand and ICF activity codes (r = –0.87 to –0.92) confirm that higher motor recovery levels were associated with reduced activity limitation in fine hand use. (Table.3,4)

These findings collectively demonstrate that motor recovery and activity-level function improve in parallel, validating BRS-hand as a predictor of functional hand performance.

Progression through Brunnstrom stages reflects reduction in spastic synergy dominance, emergence of voluntary finger extension, improved fractionation of finger movements and better motor unit recruitment and cortical reorganization.[5]

These neurophysiological improvements directly influence grasping, manipulating, and releasing objects — the exact domains assessed by SHFT and ICF d440 codes. Thus, improved corticospinal control likely explains the strong correlations observed.[4]

The findings align with studies showing that motor staging correlates with functional ability. Safaz et al. reported strong responsiveness of BRS to upper limb motor changes, while Huang et al. demonstrated good reliability and validity of BRS in stroke populations.[9,16,19] Similarly, studies using SHFT and other functional measures have shown that recovery of voluntary control predicts improved performance in daily tasks.

However, some studies have reported weaker correlations between BRS and ADL scales such as FIM. This discrepancy may arise because global ADL measures involve cognitive, balance, and environmental factors, whereas SHFT and ICF hand

codes focus specifically on hand performance, making them more directly linked to motor recovery.[17,18]

Greater improvement was seen in ICF domains of *picking up* and *grasping* compared to *manipulating* and *releasing*. These tasks require higher levels of motor selectivity and isolated finger control, which typically emerge in later Brunnstrom stages (5–6). This stage-dependent recovery pattern likely explains the slower functional gains in these domains.

The strong associations suggest that BRS-hand can serve as a simple surrogate indicator of functional hand ability, especially in resource-limited settings. Therapists may use stage progression to estimate functional prognosis and guide stage-appropriate interventions.

Despite strong correlations, factors such as sensory deficits, muscle fatigue during SHFT and learned non-use may influence functional performance and account for variability not captured solely by motor staging.

The present study included individuals in all Brunnstrom Recovery stage for Hand. Further studies can be done for the individuals in specific stage.

CONCLUSION

The present study concluded that Brunnstrom Recovery Stage for hand, ICF codes for hand function and Sollerman Hand Function Test score showed incremental improvement. There is a strong correlation between Brunnstrom Recovery Stage for hand and ICF codes for hand function as well as BRS hand and Sollerman Hand Function Test. This proves that there is a good predictive validity of BRS hand for functional activities measured by ICF codes for hand function and Sollerman Hand Function Test.

REFERENCES

1. Feigin VL, Brainin M, Norrving B, et al. World stroke organization (WSO): global stroke fact sheet. Lancet Neurol. 2021;20(10):795-820.
2. Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. Lancet. 2009;8(8):741-754.
3. Kwakkel G, Kollen BJ, van der Grond J, Prevo AJ. Probability of regaining dexterity in the flaccid upper limb: impact of severity of paresis and time since onset in acute stroke. Stroke. 2003;34(9):2181-2186.
4. Nudo RJ. Recovery after brain injury: mechanisms and principles. Front Hum Neurosci. 2013;7:887.
5. Brunnstrom S. Movement Therapy in Hemiplegia: A Neurophysiological Approach. New York: Harper & Row; 1970.
6. Huang SL, Hsieh CL, Wu RM, Tai CH, Lin CH, Lu WS. Minimal detectable change of the Brunnstrom recovery stages in patients with stroke. Neurorehabil Neural Repair. 2006;20(3):372-378.
7. World Health Organization. International Classification of Functioning, Disability and Health (ICF). Geneva: WHO; 2001.
8. Sollerman C, Ejeskär A. Sollerman hand function test: a standardised method and its use in tetraplegic patients. Scand J Plast Reconstr Surg Hand Surg. 1995;29(2):167-176.
9. Safaz I, Yilmaz B, Yasar E, Alaca R. Brunnstrom recovery stage and functional outcomes in stroke patients. NeuroRehabilitation. 2009;24(3):213-219.
10. Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, et al. Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association. Circulation. 2019 Mar 5;139(10):e56–528.
11. Renedo D, Acosta JN, Leasure AC, Sharma R, Krumholz HM, de Havenon A, et al. Burden of Ischemic and Hemorrhagic Stroke Across the US From 1990 to 2019. JAMA Neurol. 2024 Mar 4;81(4):394–404.
12. Global, Regional, and National Burden of Stroke, 1990-2021: A Systematic Analysis for Global Burden of Disease 2021 | Request PDF. ResearchGate [Internet]. 2025 Jan 28 [cited 2025 Jul 21]
13. Risk Factor Profile, Clinical and Vascular Territory Involved in Patients of Stroke Presenting to a Tertiary Care Hospital in India Over 1 Year [Internet]. [cited 2025 Jul 21].
14. Hedna VS, Bodhit AN, Ansari S, Falchook AD, Stead L, Heilman KM, et al. Hemispheric Differences in Ischemic Stroke: Is Left-

Hemisphere Stroke More Common? J Clin Neurol Seoul Korea. 2013 Apr;9(2):97–102.
15. Vitti E, Kim G, Stockbridge MD, Hillis AE, Faria AV. Left Hemisphere Bias of NIH Stroke Scale Is Most Severe for Middle Cerebral Artery Strokes. Front Neurol [Internet]. 2022 Jun 14 [cited 2025 Jul 21];13.
16. Kocyigit BF, Akaltun MS. Assessment of responsiveness of four hand-related scales in stroke patients. Acta Neurol Belg. 2021 Dec;121(6):1633–9.
17. Correlation of Voluntary Control (brunnstrom Stage of Recovery) with Activities of Daily Living (adls) and Motor Function in Stroke Patients. Bhalerao G, Chaudhari M, Rairikar S. Journal of Orthopaedic and Rehabilitation 2016 Jan-Apr; 3(1):5-7
18. Iokawa K, Sone T, Fujita T, Tsukada T, Kaneda M, Hasegawa K. Functional and cognitive variables predicting successful use of chopsticks or a spoon by the paretic upper extremity in patients following stroke: a cross-sectional study. Top Stroke Rehabil. 2019 Jan 1;26(1):1–5.
19. Meng L, Jiang X, Qin H, Fan J, Zeng Z, Chen C, et al. Automatic Upper-Limb Brunnstrom Recovery Stage Evaluation via Daily Activity Monitoring. IEEE Trans Neural Syst Rehabil Eng Publ IEEE Eng Med Biol Soc. 2022;30:2589–99

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