Correlation of Trunk Control, Sitting Balance and Functional Mobility among Patients with Sub-Acute Stroke

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Abstract

Prior research has demonstrated an association between trunk control and balance. This study aims to identify the relationship between subacute stroke patients' functional mobility and their mobility. It can help with rehabilitation and hasten recovery by evaluating a patient's functional mobility with respect to these elements. The sitting balance scale (SBS) and Trunk Control Test (TCT) stood out due to their faster completion times. Using these tools along with the Modified Forward Reach Test (MFRT) to measure the functional mobility of patients who have experienced a sub-acute stroke, this research aims to demonstrate whether seated balance and trunk control can predict functional mobility. 46 subjects were recruited for this study and the three aforementioned tools were used to evaluate them. The relevant parametric or non-parametric tests were used to analyze the data for all outcomes. This study aimed to determine whether sitting balance and trunk control can predict the level of functional mobility in people who have had subacute strokes.The analysis revealed a strong and statistically significant positive correlation between the Trunk Control Test (TCT) scores and the Modified Functional Reach Test (MFRT) measurements for all three positions: front ($r = .686$, $p < .001$), unaffected side ($r = .743$, $p < .001$), and affected side ($r = .733$, $p < .001$). Similarly, there was a strong and statistically significant positive correlation between the Sitting Balance Scale (SBS) scores and the MFRT measurements for the same positions: front ($r = .861$, $p < .001$), unaffected side ($r = .858$, $p < .001$), and affected side ($r = .859$, $p < .001$).

Keywords: Stroke, Sitting Balance, Trunk Control, Functional Mobility, Early Rehabilitation

I. INTRODUCTION

Stroke is a significant global health concern, with an estimated 17 million people experiencing a stroke each year worldwide. It is a leading cause of long-term disability and mortality, particularly in low- and middle-income countries.[1] The burden of stroke is expected to rise in the coming years due to aging populations and the increasing prevalence of risk factors such as hypertension, diabetes, and obesity. Stroke survivors often face a range of challenges, including physical impairments such as hemiparesis, sensory disturbances, and difficulties with balance and coordination. Cognitive impairments, including problems with memory, attention, and executive function, are also common. These deficits can impact the quality of life of a person and also their ability to independently perform their daily. Rehabilitation strategies are crucial for maximizing recovery and improving functional outcomes in stroke survivors.

In stroke survivors with hemiparesis, the trunk, and extremities may operate less effectively, impairing standing and sitting balance, which can impede movement and daily activities.[3] In the acute period, 80–90% of patients regain the capacity to sit independently, however, in certain severely disabled stroke patients, the inability to sit independently can last longer.[2] Therefore, one of the crucial elements that might determine a stroke patient's functional level is the measurement of their balance.[3]

Specific trunk movements are necessary to keep the center of mass within the base of support and to maintain an upright posture during weight shift. Trunk muscles play a crucial role in stabilizing the proximal body segments during various balancing tasks in individuals recovering from stroke making them essential for achieving functional independence. However, stroke impairs trunk control needed for weight-shifting and balance reactions. Patients show reduced control in all directions, with the frontal plane being the most affected.[4] Many of the early trunkal exercises may improve balancing activities in later stages of rehabilitation, thus promoting functional independence in stroke patients, making the relationship between trunk performance and balance in stroke patients an area of special interest to physiotherapists.[5]

Balance in stroke patients can be assessed in sitting and standing positions. Many acute and subacute stroke survivors struggle with maintaining balance in sitting, and posture during standing. Predicting mobility after stroke is challenging for most of these patients. However, since mobility is crucial for independent daily living, setting rehabilitation goals based on mobility prediction is essential for all survivors of stroke.[4]

Functional performance tests, such as the Romberg test, Functional Reach test, Single-Leg Stance test, Step test, and TUG (timed up & go) test, are used to assess balance ability. Ordinal scale measures are also available, including the Berg balance scale (BBS), Postural Assessment Scale for Stroke Patients (PASS), Activities-Specific Balance Confidence Scale (ABC), Motor Assessment Scale (MAS), Trunk Control Test (TCT), Trunk Impairment Scale (TIS), Brunel Balance Assessment.[1] However, a wide variety of measurement instruments have been applied in research and clinical evaluation.

As a result, it can be challenging for physical therapists to implement balance techniques that are appropriate for patients' functional levels in clinical settings. According to Park Hye-jeong's research, there are three issues with the use of measurement tools: first, it is difficult to use measurement tools in a clinical setting where many patients need to be treated in a short amount of time; second, it is not possible to request a medical insurance fee for each measurement tool under the existing medical insurance cost system; and third, when attending or after completing college, university, or graduate school, there aren't enough educational chances for assessment.[7]

To address the limitations of existing scales in assessing trunk control in stroke survivors, the Trunk Control Test (TCT) has emerged as a promising tool. The TCT is a simple and quick test that evaluates trunk movements in patients who have experienced a neurological disorder, such as a stroke. It assesses four movements: rolling from supine to weak side (T1), rolling from supine to strong side (T2), sitting up from lying-down position (T3), and sitting balance (T4). The TCT has a total score range of 0–100, with higher scores indicating better performance. Each item is scored as 0, 12, or 25. Studies have shown that the TCT has good acceptability, reliability, and responsiveness in the acute phase of stroke. It has also been found to have minimal floor and ceiling effects, indicating its suitability for a wide range of stroke survivors. The TCT demonstrates strong construct validity, correlating well with other measures of trunk control and functional abilities. Furthermore, the TCT has shown predictive validity, with higher scores being associated with better functional outcomes.[8] Its simplicity and efficiency make it a valuable tool for assessing trunk control in stroke survivors, particularly in the acute phase, aiding in early rehabilitation planning and goal setting.

The Sitting Balance Scale (SBS), developed by Medley et al to assess patients with impaired balance and gait, has shown substantial intra- and inter-rater reliability.[10] The SBS is particularly useful for examining the sitting balance in older persons who are non-ambulatory or have restricted functional mobility.[11] This scale seems to be a reliable, accurate, and thorough indicator of a patient's capacity for sitting balance, addressing limitations observed in other measures such as the Berg Balance Scale (BBS) and the Sit and Reach Test. The BBS, while widely used, can exhibit a floor effect in stroke survivors with impaired balance,[2] while the Sit and Reach Test primarily measures lower back and hamstring flexibility rather than balance. Therefore, the SBS provides a valuable tool for assessing sitting balance, especially in populations where other scales may not be as effective.[3,10] The Sitting Balance Scale (SBS) is a performance-based assessment tool designed to evaluate an individual's ability to maintain balance while seated. It is primarily employed in the evaluation of frail, non-ambulatory older adults with chronic health conditions. The SBS comprises 16 items that

encompass a range of functional tasks to assess sitting balance, such as unsupported sitting with eyes closed, turn and look behind over both shoulders while seated, and retrieving objects from the floor while seated on foam. Scoring ranges from 0 to 3, for each item, with higher scores indicating greater balance ability. The SBS has been found to be comparable to the Trunk Impairment Scale in its ability to measure sitting balance in older adults who are non-ambulatory.[10]

The Modified Forward Reach Test (MFRT) may be a helpful evaluation tool for determining sitting balance in patients who have had an ischemic stroke because it has been found to be trustworthy, responsive to modification, and somewhat correlated with functional performance. 2–8 weeks after the occurrence.[12] The MFRT is a standardized assessment tool used to evaluate sitting balance in individuals with spinal cord injuries (SCI). Derived from the original Functional Reach Test (FRT), the MFRT is specifically designed for seated individuals, broadening its applicability to a wider range of individuals with motor impairments. During the test, the individual sits in a stable position and reaches forward with one arm while maintaining a 90° angle of shoulder flexion. This task replicates a common daily activity and has been shown to effectively differentiate between individuals with various levels of paraplegia and tetraplegia. Scores below 6 or 7 inches on the MFRT mean the functional balance is limited, whereas most healthy individuals with sufficient functional balance are able to reach distances of 10 inches or more.

This research aims to demonstrate a relevant association between sitting balance and trunk control in subacute stroke survivors utilizing evaluation tools such as the SBS, TCT, and MFRT. Additionally, this study will look at whether seated balance and trunk control can predict functional mobility.

II. METHODOLOGY

This descriptive study involved a correlation analysis and was conducted at Yenepoya Physiotherapy Department, Yenepoya Medical College Hospital. Convenience sampling was used, and the sample size was determined using G Power Software. Assuming a high correlation (magnitude of 0.5) between sitting balance, trunk control, and functional mobility, 46 subjects were included to detect the anticipated correlation with 95% power and a 5% level of significance. The inclusion criteria consisted of sub-acute stroke patients (7 days to 3 months post-episode) with a Montreal Cognitive Assessment score greater than 26. Exclusion criteria included bilateral stroke, recurrent stroke after admission, a history of neurological disorders such as Parkinson's disease, and early transfer within 10 days of hospitalization.

Outcome Measures:

The Sitting Balance Scale (SBS) is a performance-based assessment tool developed to evaluate an individual's ability to maintain balance while seated. It consists of 11 items that assess various aspects of sitting balance, including sitting unsupported with eyes open, sitting unsupported with eyes closed, using arms as levers, reaching forward with an outstretched arm, picking up an object from the floor, placing an alternate foot on a raised object, reaching laterally with an outstretched arm, turning to look behind over both shoulders, performing a lateral bend to the elbow, and completing sit-to-stand transfers. Each item is scored ranging from 0 to 4, with higher scores indicating better balance ability. The maximum score achievable on the SBS is 44, with higher scores indicating a higher level of functionality in sitting balance. The SBS has been found to be comparable to the Trunk Impairment Scale in its ability to measure sitting balance in older adults who are non-ambulatory.

Trunk Control Test (TCT) was used to assess older individuals' sitting balance. The TCT consists of the following four movements: supine to sitting, supine to roll to the affected and unaffected side, and maintaining balance with both feet on the ground for 30 seconds while seated. A score of 0 shows that the subject is unable to do the movement, while a score of 12 indicated that the movement was performed in an aberrant manner. Each item was scored from 0 to 25 points, with a maximum score of 100 achievable. Finally, a score of 25 indicated that regular movement was accomplished.

Modified Forward Reach Test (MFRT) a modified version of the Functional Reach Test, developed by Duncan, was performed while the subject was seated close to the wall with a leveled yardstick on the wall at the height of their acromion level to measure their maximum forward reach while sitting in a fixed posture. The subject was seated with both feet flat on the floor and the hips, knees, and ankles all flexed 90 degrees. The subject was seated against the wall with one upper extremity flexed to 90 degrees as the initial reach was measured. The placement of the fifth finger along the yardstick was marked. Testing had three conditions, each having three trials:

- Sit with the uninvolved side near the wall and leaning forward
- Sit with the back to the wall and leaning right
- Sit with the back to the wall leaning left.

The subject was instructed to lean as far as they can without rotation or touching the wall during the leaning. Once more, the little finger was marked along the yardstick. During leaning, the distance covered was measured in cm and was taken as the result. The distance covered by the acromion during leaning was taken if the patient could not raise his involved arm. The first trial in each direction was not included in the final results. The subject was asked to sit and rest for seconds between trials.

Procedure:

Medical chart reviews or brief interviews were used to gather information on the patient's general characteristics, such as age, sex, affected sides, disease duration, and Montreal Cognitive Assessment scores. Those who met the inclusion criteria were provided with the participants' information sheet and consent to partake in the study.

When performing the Sitting Balance Scale (SBS), Trunk Control Test (TCT), and modified Functional Reach Test (MFRT), several safety measures were observed. These included ensuring a stable seating surface, clearing the area of hazards, providing clear instructions and demonstrations, closely monitoring the individual during the test to prevent falls or loss of balance, and using additional support or assistance as needed. These precautions were essential to ensure the safety and well-being of the individuals undergoing assessment.

All tests were conducted in the following sequence: SBS, TCT, and MFRT.All tests were conducted by the Principal Investigator in the Physiotherapy Out-Patient Department at Yenepoya Medical College Hospital. The testing duration ranged from 20-30 minutes.

Statistical Analysis:

SPSS 20.0 was used for data analysis. Summarization of the continuous variables was done using mean and standard deviation. The categorical variables were summarized using frequency and percentage. The correlation among study variables was studied using Pearson's correlation.

The readings from the three outcome measures; SBS, TCT, and MFRT were used in the correlation.

RESULTS & INTERPRETATIONS

Participants

A total of 46 participants met the inclusion criteria for this study. All participants were sub-acute stroke patients, defined as being between 7 days and 3 months since their stroke episode. Each participant scored above 26 on the Montreal Cognitive Assessment (MoCA), ensuring adequate cognitive function for the tasks involved

TABLE 1: DEMOGRAPHIC DATA OF AGE & STROKE DURATION

	N	MINIMUM	MAXIMUM	MEAN
AGE	46	42	78	59.15
TIME SINCE EPISODE (IN DAYS)	46	18	89	50.61

TABLE 2: GENDER DISTRIBUTION

	FREQUENCY	PERCENT
F	15	32.6
M	31	67.4
TOTAL	46	100

Demographics

The participants had a mean age of 59.15 years, and the mean time since their stroke episode was 50.61 days. In terms of gender distribution, 32.6% of the participants were female, while 67.4% were male. The majority of the participants (71.7%) had suffered an ischemic stroke, with the remaining 28.3% having experienced a hemorrhagic stroke. Regarding the hemiplegic side, 37% of the participants had left-sided hemiplegia, and 63% had right-sided hemiplegia

TABLE 3: TYPE OF STROKE

	Frequency	Percent
Hemorrhagic	13	28.3
Ischemic	33	71.7
Total	46	100

TABLE 4: HEMIPLEGIC SIDE

	Frequency	Percent
Left	17	37.0
Right	29	63.0
Total	46	100

Data Analysis

The data collected from the Sitting Balance Scale (SBS), Trunk Control Test (TCT), and Modified Functional Reach Test (MFRT) were analyzed to determine the correlation between these measures.

Trunk Control Test (TCT) and Modified Functional Reach Test (MFRT):

The analysis revealed a strong and statistically significant positive correlation between the TCT scores and the MFRT measurements for all three positions: front, unaffected side, and affected side. The correlation coefficients (r) for each position are as follows:

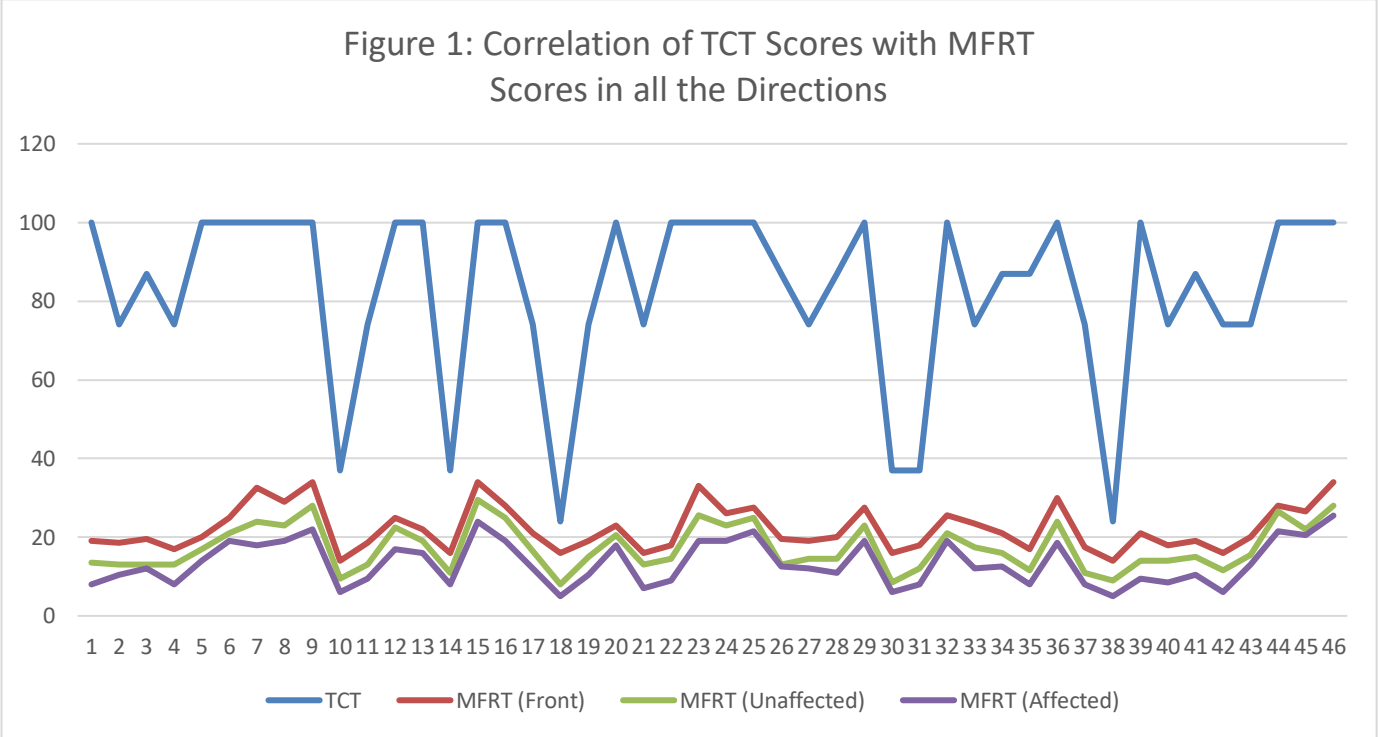
- Front: $r = .686$, $p < .001$
- Unaffected side: $r = .743$, $p < .001$
- Affected side: $r = .733$, $p < .001$

TABLE 5: RELATIONSHIP OF TRUNK CONTROL WITH FUNCTIONAL MOBILITY OF PATIENTS USING PEARSON TEST

		MFRT(in cm)		
		Front	Unaffected	Affected
TCT	Pearson	.686**	.743**	.733**

(out of 100)	Correlation			
	Sig. (2-tailed)	<.001	<.001	<.001

**statistically significant*



Sitting Balance Scale (SBS) and Modified Functional Reach Test (MFRT):

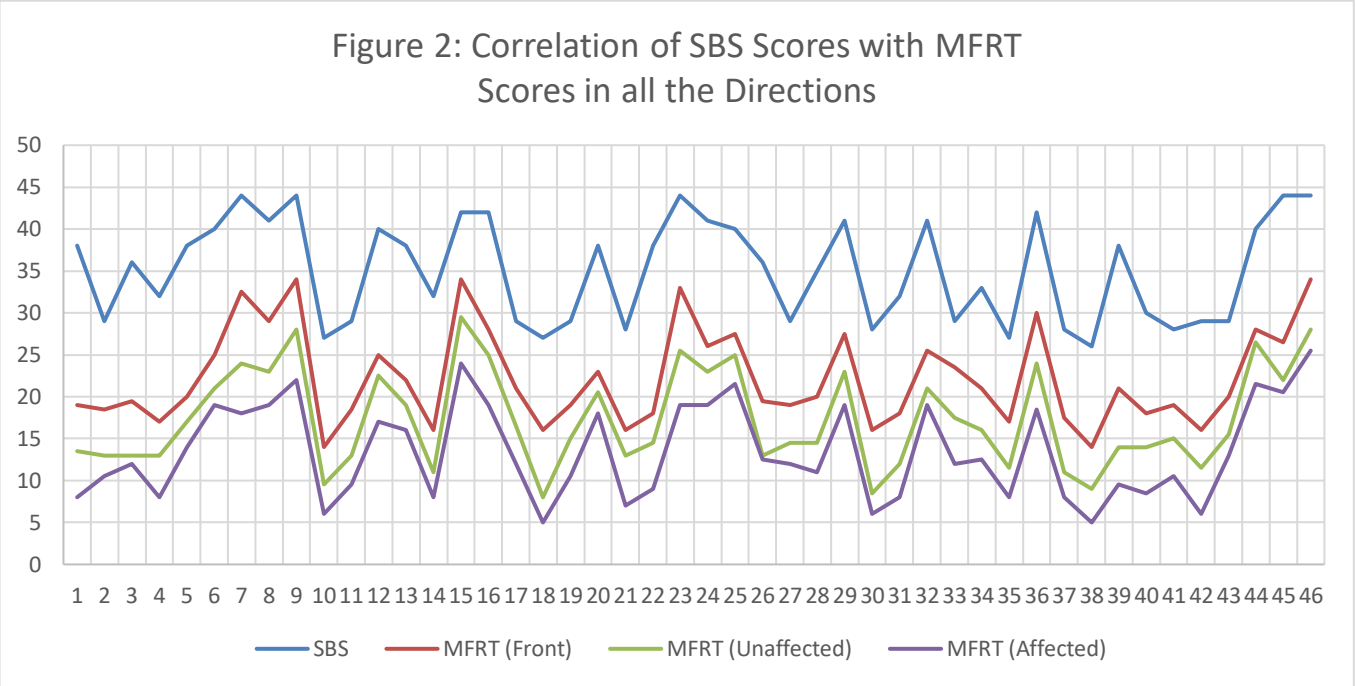
Similarly, there was a strong and statistically significant positive correlation between the SBS scores and the MFRT measurements for all three positions: front, unaffected side, and affected side. The correlation coefficients (r) for each position are as follows:

- Front: r = .861, p < .001
- Unaffected side: r = .858, p < .001
- Affected side: r = .859, p < .001

TABLE 6: RELATIONSHIP OF SITTING BALANCE WITH FUNCTIONAL MOBILITY OF PATIENTS USING PEARSON TEST

		MFRT(in cm)		
		Front	Unaffected	Affected
SBS (out of 44)	Pearson Correlation	.861**	.858**	.859**
	Sig. (2-tailed)	<.001	<.001	<.001

**statistically significant*



Correlation between Sitting Balance Scale (SBS) and Trunk Control Test (TCT):
The correlation between the SBS and TCT has already been established in an earlier study, further supporting the findings of this research.3
These findings suggest that both trunk control and sitting balance are closely related to functional mobility as measured by the MFRT in patients with sub-acute stroke. The strong positive correlations indicate that improvements in trunk control and sitting balance may lead to better functional reach, highlighting the importance of these factors in stroke rehabilitation.

III. DISCUSSION

Sitting balance is a fundamental aspect of postural control, and its impairment is a common and debilitating consequence of stroke. This impairment is multifactorial, resulting from muscle weakness, diminished proprioception, and deficits in motor control. Post-stroke, patients often struggle with asymmetry in weight distribution, reduced trunk stability, and a decreased ability to adjust posture in response to perturbations. These deficits not only affect a patient's ability to sit independently but also impede the execution of functional tasks such as reaching, transferring, and transitioning from sitting to standing. Maintenance of the sitting balance and trunk control should be done before functional movement, and restoring the postural control and mobility.

The challenges associated with impaired sitting balance are profound. Stroke survivors may experience an increased risk of falls, difficulty in performing daily living activities, and overall reduced independence. The inability to maintain or regain sitting balance can slow down the entire rehabilitation process, delaying the achievement of subsequent mobility milestones such as standing and walking. Therefore, enhancing sitting balance is a critical goal in stroke rehabilitation, aimed at improving overall functional outcomes and quality of life.

This study was designed to explore the correlation between trunk control, sitting balance, and functional mobility in patients with sub-acute stroke. Participants were rigorously selected based on specific inclusion criteria: they had to be within 7 days to 3 months post-stroke and possess a Montreal Cognitive Assessment (MoCA) score greater than 26, ensuring they had the cognitive capacity to participate fully in the assessment tasks. The demographic analysis revealed a diverse participant pool, with a mean age of 59.15 years, a mean time since stroke of 50.61 days, and varied distributions in terms of gender, type of stroke, and hemiplegic side.

The instruments used for data collection were the Sitting Balance Scale (SBS), Trunk Control Test (TCT), and Modified Functional Reach Test (MFRT). The SBS evaluates a patient's ability to maintain and adjust sitting posture. The TCT assesses trunk movement control, which is crucial for maintaining balance and performing daily activities. The MFRT measures the reach distance while maintaining a sitting position, providing insight into functional balance and stability.

The study's results highlighted strong and statistically significant positive correlations between the TCT scores and the MFRT measurements for all three assessed positions: front, unaffected side, and affected side. This indicates that patients with better trunk control had greater functional reach capabilities in various directions. Similarly, the SBS scores showed strong and statistically significant positive correlations with the MFRT measurements for the same positions, underscoring the importance of sitting balance in functional reach.

These correlations suggest that improvements in trunk control and sitting balance are associated with enhancements in functional reach, which is a critical aspect of mobility. The established correlation between SBS and TCT in earlier studies reinforces these findings, providing a solid foundation for interpreting the results of this study. SBS proved to have the highest predictive validity in discriminating mobility levels. The SBS consists of control of the upper trunk, the lower trunk, and coordination, along with specific task item to examine dynamic balance capability, required for sit-to-stand.

The findings of this study have significant implications for the rehabilitation of stroke patients. Understanding the strong correlation between trunk control, sitting balance, and functional mobility can inform the development of targeted therapeutic interventions. By prioritizing exercises and therapies that enhance trunk control and sitting balance, clinicians can more effectively address the foundational aspects of postural control, leading to broader improvements in functional mobility.[16,17]

One of the key implications of this correlation is its potential to predict rehabilitation outcomes. Clinicians can use the relationship between TCT, SBS, and MFRT scores to identify patients who are likely to benefit from specific interventions. For instance, a patient with low TCT and SBS scores but high potential for improvement in these areas might be prioritized for intensive trunk and balance training. Such targeted approaches can lead to faster and more efficient rehabilitation, as improvements in these core areas can facilitate earlier progress to standing and walking.[10,11]

Moreover, enhancing trunk control and sitting balance is directly linked to the prevention of secondary complications such as falls and pressure sores, which are common in stroke survivors with impaired balance.[13,15,17] By improving these aspects, patients can achieve greater independence in daily activities, reduce their reliance on caregivers, and experience a better overall quality of life.

The study's findings also highlight the importance of a multidisciplinary approach to stroke rehabilitation. Physical therapists, occupational therapists, and other rehabilitation professionals must collaborate to design comprehensive programs that address the multifaceted needs of stroke patients. Interventions might include core strengthening exercises, balance training, proprioceptive training, and functional reach exercises, all tailored to the specific deficits and capabilities of each patient.

V. CONCLUSION

This study underscores the critical role of trunk control and sitting balance in the functional mobility of stroke patients. There is strong positive correlations between these factors and functional reach which emphasize the need for targeted rehabilitation strategies.

Limitations:
Despite the promising findings, this study has several limitations that must be acknowledged:

Firstly, the sample size was relatively small, with an uneven distribution of ischemic and hemorrhagic stroke patients and an imbalance in the side of hemiplegia. This uneven distribution may limit the generalizability of the results to the broader stroke population. Future studies should aim for larger, more balanced sample sizes to confirm the findings and enhance their applicability.

Secondly, the Trunk Control Test (TCT) used in this study, while valuable, is not capable of providing a qualitative examination of trunk movement. The TCT primarily assesses the ability to perform certain trunk movements but does not capture the strength or quality of these movements in detail. The use of a trunk muscle strength dynamometer could provide more comprehensive insights into trunk control by quantitatively measuring muscle strength and offering a more detailed assessment.

Thirdly, psychological factors were not considered in this study. Factors such as motivation, depression, and cognitive impairments can significantly influence rehabilitation outcomes but were not accounted for in the analysis. Including psychological assessments in future studies could provide a more holistic understanding of the factors affecting rehabilitation and help in developing more comprehensive treatment plans.

Additionally, the study did not consider the potential impact of comorbid conditions that are common in stroke patients, such as cardiovascular disease, diabetes, and other neurological disorders. These conditions could influence both the ability to participate in rehabilitation and the overall outcomes, and their exclusion is a limitation.

Lastly, the study's reliance on self-reported measures and therapist-administered assessments may introduce bias. Objective, technology-based assessments could reduce this bias and provide more reliable data. Incorporating wearable technology or motion capture systems could offer more precise and objective measurements of trunk control, sitting balance, and functional mobility.

In summary, while this study provides valuable insights into the relationship between trunk control, sitting balance, and functional mobility in sub-acute stroke patients, the limitations highlight the need for further research. Addressing these limitations in future studies could enhance the understanding and development of effective rehabilitation strategies for stroke survivors.

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