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RESEARCH ARTICLE

Relationship of balance and functional independence among chronic middle cerebral artery stroke patients

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ABSTRACT

Background: In global acute care settings, stroke is the second most common cause of mortality and morbidity, balance dysfunction and dependency on care are recurrent themes among clients with middle cerebral artery stroke.

Objective: The purpose of this study was to establish relationship between balance and level of functional independence among chronic middle cerebral stroke patients.

Methods: A cross-sectional analytical study was conducted after getting ethical approval (LCPT/DPT/23/947) from Lahore College of Physical Therapy in Gurkhi Hospital, General Hospital and Ittefaq Hospital. The sample of 127 patients in the age group of 45-65; diagnosed with mild/moderate stroke, during rehabilitation at 6-12 months post-stroke. The Berg Balance Scale was employed in this study for describing balance and the Functional Independence Measure for independence in activities. SPSS version 26 was used for data analysis.

Results: The patients' average age was 54.36±2.93 years, and 38.6% were 51-55 years old. Of these 72.4% were male and 27.6% were female. The mean Functional Independence Measure (FIM) motor of 57.65±8.65 and cognitive of 27.40±3.02; Berg Balance Scale mean was 31.82±5.00. Berg Balance Scale had significant positive relationship with the motor ($t = 0.649$, $p < 0.05$) and cognitive component ($r = 0.403$, $p = 0.00$) and total FIM ($t = 0.625$, $p < 0.05$).

Conclusion: The study found that balance and functional independence, both motor and cognitive, are significantly correlated in chronic stroke patients, indicating that balance disturbances strongly influence functional capacity.

Keywords: Balance, functional independence, middle cerebral artery, stroke.

DOI: http://doi.org/10.33897/fujrs.v5i2.417

Introduction:

Stroke is a sudden loss in neurological function caused by any disruption or complete blockage of brain's blood supply.(1) Brain is supplied by the terminal divisions of internal carotid arteries, Anterior and Middle cerebral artery, and vertebral artery named posterior cerebral artery. The Middle Cerebral Artery is the critical vessel, highly involved in acute stroke supplying frontal, parietal, and lateral aspect of temporal lobes of cerebral hemisphere.(2,3)

The incidence of stroke increased with age as it is highly prevalent in men at a younger age with greater mortality risk in women.(3) Being second mortality leading pathology; it is 2.6% prevalent among adults of above age 20 years in USA that is 1151 to 1216/100,000 prevalent in above 75 years age.(3,4) Similarly; In Pakistan, 13.84% and 1.2% prevalent in Karachi and KPK respectively among 60 years of age.(5,6) Age, gender, race, genetics, hypertension, diabetes, hyperlipidemia, obesity, smoking, alcohol consumption, presence of any cardiac condition and physical inactivity are the major risk factors of middle cerebral artery stroke (MCAS).(4-5,7)

MCAS characterized contralateral spastic hemiparesis and sensory loss of face, upper extremity and lesser in lower extremity, aphasia, perceptual deficits, paralysis of gaze, attention deficits and

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Received: April 1st, 2024; **Revision 1:** September 13th, 2024; **Revision 2:** November 19th, 2024.
Acceptance: December 19th, 2024.
How to Cite: Muzaffar R, Safdar N, Salik S, Munawar R, Faisal S. Relationship of balance and functional independence among chronic middle cerebral artery stroke patients. Foundation University Journal of Rehabilitation Sciences. 2025 July;5(2):55-61.

homonymous hemianopia.(4) Stroke increase 75-99% chances of the development of cardiac arrest, fracture, balance, vision, cognitive, pulmonary and Psychiatric comorbidities in patients affecting their functional activities and independency.(8) The most frequent complication reported was balance impairment affected 48.1% through impaired knee and ankle muscularity. Furthermore, 48% had complain of gait abnormalities, and 60% are functionally impaired within 36 to 48 hours of a stroke with no direct correlation observed between balance disturbance and the specified functional dependency period.(9-11)

Nair et al. supported that balance is the major problem in the stroke patients affecting their ability to maintain their center of gravity, stability and mobility during upright position. This impairment further leads to the development of sensory, motor, cognitive, perceptual and functional impairments affecting their quality of life.(9) This impairment affects functional independency as Fiedorová et al. stated the disturbed either all or some of functional mobility skills, ADLs and IADLs among hemiparetic patients severely compromised functional independence causing the patient to depends upon either human resource or any device for his performance.(10)

Additionally; Khan et al. reported using walking aid and weakness in ankle dorsiflexors and knee muscle and increases post-stroke balance problem and functional dependence. However, it has not reflected on the correlation between balance disturbances and the level of functional dependence in patients with stroke originating from the middle cerebral artery.(11) Therefore; the current study highlighted the balance deficits and functional impairment in chronic post stroke patients and the relationship between balance and functional independence among chronic stroke patients. This study will be helpful for clinicians in clinical decision making regarding balance deficits to manage which will prevent long term complications linked with chronic stroke patients.

Methods:

The analytical cross-sectional designed study was executed from July 2023 to December 2023 after receiving an ethical approval from Research Committee of Lahore College of Physical Therapy, Lahore Medical and Dental College with Ref. No LCPT/DPT/23/947. The sample size of 127 stroke patients was calculated through WHO sample size calculator (n= Z2 P (1-P) /d 2 as Prevalence = 0.138 (5), d = 0.06, Confidence level = 95). Subjects were recruited from Ghurki Trust and Teaching Hospital, General Hospital and Ittefaq Hospital by non-Probability Convenient Sampling technique. Specifically, male and female patients aged between 45 and 65 years who had suffered ischemic middle cerebral artery stroke which permitted being in a 6-12 month post-rehabilitation physiotherapy protocol aimed to improve muscular control were included in study. Additionally; patients having previous history of TBI, acute body Infection, diabetes and cardiac conditions were excluded in this study.

Patients' verbal permission for participation in the study was first sought, followed by an assessment of basic demographics, and balance and functional independence questionnaires. Balance was assessed by using Berg Balance Scale (BBS) while functional independency was assessed by using Functional Independence Measures (FIM). Each patient was evaluated based on their performance of specific activities outlined in the questionnaire, with observations recorded accordingly. Data analysis was done using SPSS, version 26 in which results were expressed in the form of mean ± S.D along with frequencies and percentages. Additionally; the correlation between balance and functional independency was analyzed by using Pearson Correlation test.

Results:

The results of analysis were described in tabulated form. Table 1 provided the detailed results of demographic variables of selected stroke patients. The frequency (%) of FIM and BBS are completely described in detail in Table 2 and Table 3.

Table 2 of FIM showed that maximum patients lie within the range of Modified independent to moderate assistance in which maximum patients required supervision in performing their normal activities. Furthermore; according to BBS analysis; maximum patients required supervision or any support during any activity that was in detailed described in Table 3.

The correlation results between balance deficit and functional independence is shown in Table 4 in which BBS showed strong positive correlation with FIM with 0.625 value, p-value <0.001. However; BBS showed significant strong positive correlation with motor component of FIM with 0.649 while having moderate positive correlation with cognitive component of FIM with 0.403 value, p-value <0.001.

Discussion:

The present study adopted a cross-sectional research design to explore the association between balance and functional dependency in the patients having CMA stroke. The investigations showed that

Table 1: Outcome variables of Stroke patients

Variables			Mean ± S.D	Frequency (%)
Age	45-50 years		54.36±2.93	13 (10.2%)
	51-55years			49 (38.6%)
	56-60 years			38 (29.9%)
	61-65 years			27 (21.3%)
Gender	Male		-	92 (72.4%)
	Female			35 (27.6%)
FIM	FIM-M		57.65 ± 8.645	-
	FIM- C		27.40 ± 3.022	-
BBS	Walking with assistance	21-40	31.82 ± 5.00	121 (95.3%)
	Independent	41-56		6 (4.7%)

Table 2: Functional independence Measure (FIM) frequency (%):

Functional independence Measure (FIM)	Complete independence (7)	Modified independence (6)	Supervision (5)	Minimal assistance (4)	Moderate assistance (3)	Maximal assistance (2)	Total assistance (1)
Eating	1(0.8%)	24 (18.9%)	54 (42.5%)	41(32.3%)	6 (4.7%)	1 (0.8%)	0 (0%)
Grooming	1(0.8%)	15 (11.1%)	21 (16.5%)	41(32.3%)	49(38.6%)	0 (0%)	0 (0%)
Bath	0 (0%)	7 (5.5%)	12 (9.4%)	34(36.8%)	69(54.3%)	5 (3.9%)	0 (0%)
Dressing Upper Body	0 (0%)	4 (3.1%)	10(7.9%)	39(30.7%)	67(52.8%)	7(5.5%)	0(0%)
Dressing Lower Body	0 (0%)	4 (3.1%)	14(11%)	55(43.3%)	49(38.6%)	5(3.9%)	0(0%)
Toilet	0 (0%)	12 (9.4%)	7(5.5%)	38(29.9%)	67(52.8%)	3(2.4%)	0(0%)
Swallowing	6 (4.7%)	33(26%)	48(37.8%)	29(22.8%)	7(5.5%)	4(3.1%)	0(0%)
Bladder Controlling	4(3.1%)	37(29.1%)	68(53.5%)	16(12.6%)	2(1.6%)	0(0%)	0(0%)
Bowel Controlling	4(3.1%)	39(30.7%)	68(53.5%)	15(11.8%)	1(0.8%)	0(0%)	0(0%)
bed/chair/wheelchair Transfers	0(0%)	20(15.7%)	24(18.9%)	57(44.9%)	25(19.7%)	1(0.8%)	0(0%)
Toilet Transfer	0(0%)	11(8.7%)	13(10.2%)	49(38.6%)	53(41.7%)	0(0%)	1(0.8%)
Bath/shower Transfer	0(0%)	9(7.1%)	12(9.4%)	33(26%)	68(53.5%)	4(3.1%)	1(0.8%)
Walk	0(0%)	1 (0.8%)	6 (4.7%)	88(69.3%)	31(24.4%)	0(0%)	1(0.8%)
Stairs	0(0%)	2 (1.6%)	4 (3.1%)	59(46.5%)	53(41.7%)	8 (6.3%)	1 (0.8%)
Comprehension	6(4.7%)	41 (32.3%)	49 (38.6%)	28 (22%)	3 (2.4%)	0 (0%)	0 (0%)
Expression	7(5.5%)	42 (33.1%)	44 (34.6%)	33 (26%)	1(0.8%)	0 (0%)	0 (0%)
Socialization	7(5.5%)	52 (40.9%)	59(46.6%)	8(6.3%)	1(0.8%)	0(0%)	0(0%)
Problem Solving	12(9.4%)	80(63%)	31(24.4%)	2(1.6%)	2(1.6%)	0(0%)	0(0%)
Memory	14(11%)	90(70.9%)	19(15%)	2(1.6%)	1(0.8%)	1(0.8%)	0(0%)

Table 3: Berg Balance Scale frequency (%)

Variables	Detailed	Frequency (%)
Sitting	Safely sitting and maintaining for 2 minutes	88 (69.3%)
	Supervised sitting for 2 minutes	39 (30.7%)
	Sitting for only 30 seconds	0 (0%)
	Sitting for only 10 seconds	0 (0%)
	Difficulty in sitting for 10 seconds without support	0 (0%)
Sit to Stand position	Able to stand without using hands and stabilize independently	45 (35.4%)
	Independent standing with hand support	74 (58.3%)
	Standing with hand support for several minutes	8 (6.3%)
	Standing with little support	0 (0%)
	Standing with moderate to maximum support	0 (0%)
Stand to Sit position	Safely sitting with little hand support	23 (18.2%)
	Control standing through hand support	82 (64.6%)
	Control standing by the leg support from chair	22 (17.3%)
	Uncontrolled standing with independent sitting	0 (0%)
	Required maximum support for standing	0 (0%)
Transfers	Safely transfer by little hand support	22 (17%0
	Safely transfer by certain support of hands	75 (59.1%)
	Safely transfer under supervision or on verbal command	25 (19.7%)
	Safely transfer by one person assistance	5 (3.9%)
	Safely transfer by two person assistance	0 (0%)
Standing	2 minutes safely standing without supervision	23 (18.1%)
	2 minutes safely standing under supervision	62 (48.8%)
	30 seconds safely standing unsupported	41 (32.3%)
	Safe standing within 30 seconds unsupported by multiple tries	0 (0%)
	Difficulty to stand 30 seconds without support	1 (0.8%)
Closed eye Standing	10 seconds standing without supervision	10 (7.9%)
	10 seconds standing with supervision	45 (35.4%)
	Safe standing for 3 seconds	63 (49.6%)
	Safe standing for 3 seconds having difficult in closing eye	8 (6.3%)
	Required support for prevent fall	1 (0.8%)
Joined feet Standing	Safe standing for 1 minute with closed feet	4 (3.1%)
	Safe standing for 1 minute with closed feet under supervision	22 (17.3%)
	Safe standing for 30 seconds with closed feet under supervision	69 (54.3%)
	Safe standing for 15 seconds with closed feet with support	31 (24.4%)
	Difficulty in standing for 15 seconds with closed feet with support	1 (0.8%)

Standing in Tandem pattern	Holding tandem standing position independently for 30 seconds	0 (0%)
	Holding standing position with feet ahead independently for 30 seconds	14 (11%)
	Holding small taken steps independently for 30 seconds	51 (40.2%)
	Holding small taken steps independently for 30 seconds under supervision	60 (47.2%)
	Balance lost during standing and stepping	2 (1.6%)
One leg Standing	Lift one leg and stand for more than 10 seconds independently	2 (1.6%)
	Lift one leg and stand for 5 to 10 seconds independently	8 (6.3%)
	Lift one leg and stand for more than 3 seconds independently	62 (48.8%)
	Difficulty in lifting one leg for 3 secs while stand without support	54 (42.5%)
	Required assistance for lifting	1 (0.8%)
Trunk rotation (fixed feet)	Looks behind from both sides and weight shifts well	3 (2.4%)
	Turning to one side with less weight sifting on other side	39 (30.7%)
	Maintaining balance while turning to both sides	64 (50.4%)
	Turning to any side under supervision	19 (15%)
	Turning any side with assistance to avoid fall or balance disturbance	2 (1.6%)
Picking objects from floor	Able to pick up slipper safely and easily	2 (1.6%)
	Able to pick up slipper but needs supervision	10 (7.9%)
	Easily reach up to 2 to 5cm or 1-2 inches without losing balance but difficulty in picking up things from floor	49 (38.6%)
	Required supervision with inability to pick up things	50 (39.4%)
	Required assistance while picking things to avoid fall	16 (12.6%)
360° Whole body Turn	Able to turn 360 degrees safely in 4 seconds or less	0 (0%)
	Safely 360^0 turn towards any side within or less than 4 seconds	6 (4.7%)
	Safely and slowly take 360^0 turn to any side	84 (66.1%)
	Safely and slowly take 360^0 turn under supervision and verbal cuing	36 (28.3%)
	Required assistance for 360^0 turning	1 (0.8%)
Stepping on Stool	Safely and independently stand on stool with completing total 8 steps within 20 sec	0 (0%)
	Safely and independently stand on stool with completing total 8 steps within in more than 20 sec	1 (0.8%)
	Safely took 4 steps and be in standing position under supervision	59 (46.5%)
	Safely took more than 2 steps with little assistance	65 (51.2%)
	Required maximum assistance while taking steps	2 (1.6%)
Forward reaching in standing	Confidently and easily reach forward up to 25 cm or 10 inches	0 (0%)
	Confidently and easily reach forward up to 12 cm or 5 inches	10 (7.9%)
	Confidently and easily reach forward up to 5 cm or 2 inches	55 (43.3%)
	Confidently and easily reach forward under supervision	61 (48%)
	Required assistance or support to avoid balance loss	1 (0.8%)

Table 4: Correlation of balance and functional Independence in MCAS:

Variable	BBS	
	Pearson Value	P-value
FMI	0.625	<0.001
FMI-M	0.649	<0.001
FMI-C	0.403	<0.001

10-69% of examined patients complained of balance impairments during the stand, with the eyes closed, with feet parallel and close together, standing with feet abreast and tight, one leg standing with the trunk tilted, turning 360 degrees, reaching out for an object, and stepping. Moreover, 32-56%, the patient needed modified independence to moderate assistance helps within the tasks executed in their daily lives.

The BBS and FIM scoring showed patients suffered with MCAS had balance issues that affect their quality of life and need supervision or assistance for their daily activities of life. Tatsuya et al. confirmed that physical activities required adequate balance for accurate execution of any performance. In stroke patient's balance disturbance affect their activities as different activities are highly associated with balance. (12) This supported current study results as the patient had difficulty in standing and sitting with closed eyes and legs and grooming activities. However, the former study focuses on the evaluation of validity of Balance evaluation test on the physical activity and muscular tone of acute stroke patients while current study determines to find out the association of balance impairment with the functional independence among chronic middle cerebral artery stroke patient.

Similarly; the evaluation of FIM confirmed that patients required modified to moderate supervision for the performance of any activity. This was further confirmed by BBS scoring as patients required the definite need of hand or any assistance for transfer or walking. This assistance was rule out by Santos et al. that functional independence capacity of stroke patients is reduced either in acute or chronic stage. This reduction is completely dependent on the weakness of anti-gravity muscles of axial and trunk system that provide the control, balance and stability to body.(13) This further support the positive moderate relationship of BBS with motor component of FIM as compared to cognitive component. The weakness in body highly affected the balance that affect functional activities in MCAS.

Additionally; Vincent et al. reported a significant positive relationship of balance with functional independence for the physical performance in stroke patients. Walking, sit to stand, transfer and grooming or self-caring are highly affected by balance disturbance. (14) This again supported the current study results as BBS had moderate positive relationship with FIM. Fujita et al. further reported the FIM transfer and stair climbing disturbance is strongly associated with the BBS scoring in stroke patients.(15) This again confirmed results as patients reported required functional dependence in transfer and stair climbing wither by any supervisor support or by any assistance device.

Having its strength; the study had some limitations. The present study has some limitations: it involved only chronic stroke patients, excluding those with acute stroke, thus limiting generalization of results. Future studies should, therefore, include both acute and chronic stroke patients to increase their understanding of the relationship between balance and functional independence. Furthermore, this work was confined to the effects of balance and functional impairment due to MCA stroke only. The studies in future should compare Posterior, Anterior, and Middle Cerebral Artery stroke and better define severity of balance and functional restrictions and its relation to various types of strokes.

Conclusion:

Stroke is a leading cause of balance impairments and functional dependency, particularly in patients with middle cerebral artery stroke. The study found a moderate to strong positive correlation between balance and functional independence, both motor and cognitive, among stroke patients, significantly impacting their quality of life. Notably, motor independence was more profoundly affected by balance disturbances, highlighting the critical role of balance in functional outcomes for stroke survivors.

Disclaimer: None to declare.

Conflict of interest: None to declare.

Source of funding: None to declare.

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