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ORIGINAL RESEARCH

Assessing the Correlation between Neuroimaging and Motor-Functional Recovery in Ischaemic Stroke Patients

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ABSTRACT
Background: Stroke is the second largest cause of death globally and contributes significantly to global mortality. The present study was conducted to correlate motor and functional recovery with Neuroimaging in patients with ischemic stroke.**Materials & Methods:**56 patients of ischaemic stroke of both genders were selected. In all patients, Motor and functional assessment were done using Fugl-Meyer Assessment (FMA), and Barthel Index (BI). FMA and BI were correlated with the radiological assessment using ASPECTS on Non-contrast computed tomography (NCCT) of head. **Results:**Age group 41-50 years had 5 males and 4 females, 51-60 years had 10 males and 9 females, 61-70 years had 7 males and 11 females and >70 years had 8 males and 2 females. The difference was significant (P< 0.05). Duration of stroke was 6 months- 2 years seen in 36 and >2 years in 20. Side was right in 39 and left in 17. ASPECTS score 0-4 was seen in 7, 5-7 in 22 and 8-10 in 27. BARTHEL INDEX 0-20 was seen in 2, 21-60 in 14 and >60 in 40. FUGL MEYER ASSESSMENT <55 was seen in 20, 56-79 in 17 and >79 in 19 patients. The difference was significant (P< 0.05). There was a statistically significant difference in functional independence and motor function between the better and worse ASPECTS group.**Conclusion:** There is a strong association between ASPECTS and FMA and BI. Long-term functional and motor outcomes are positively correlated with higher ASPECTS at stroke start. In order to improve the functional outcome, prevent complications, and assist stroke survivors in becoming more independent in their everyday activities, ASPECTS can be used to plan rehabilitation interventions based on the patients' anticipated recovery and to set realistic goals on an individual basis early on.
Keywords: Barthel Index, Fugl-Meyer Assessment, Stroke

INTRODUCTION

Stroke is the second largest cause of death globally and contributes significantly to global mortality.[1] of all neurological illnesses globally, stroke is responsible for the highest percentage of Disability Adjusted Life Years (DALYs) (47.3%). One of the most significant post-stroke consequences is functional and motor disability.[2] Just around 14% of stroke patients fully recover, while 25–50% need some help and over 50% become permanently dependent on others for daily life activities. After a stroke, rehabilitation

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is crucial to helping the patient overcome their limitations and become physically, socially, and communally independent.[3]

Because it is widely accessible, efficient, and reasonably priced, computed tomography (CT) is the preferred imaging method for the preliminary evaluation of a suspected stroke.[4] The CT brain allows for quick evaluation of patients with acute stroke and is a useful neuroimaging marker to measure acute treatment outcomes.[5] The Alberta Stroke Programme Early Computed Tomography Score (ASPECTS) was created to measure the ischemia changes on CT inside the Middle Cerebral Artery (MCA) area. In clinical practice, it is widely used to evaluate the extent of early ischemic alterations on brain imaging for the treatment of acute stroke.[6] In acute ischemic stroke patients, ASPECTS has demonstrated a strong connection with the Glasgow Coma Scale, National Institute of Health Stroke Scale, modified Rankin Scale, BI, and Functional Independence Measure.[7]

AIM AND OBJECTIVES

The present study was conducted to correlate motor and functional recovery with Neuroimaging in patients with ischaemic stroke.

MATERIALS AND METHODS

Study Design

This was an observational, cross-sectional study designed to evaluate the correlation between motor and functional recovery with neuroimaging findings in patients with ischaemic stroke.

Study Population

The study included 56 patients diagnosed with ischaemic strokeof both genders. All participants provided written informed consent before their inclusion in the study.

Study Place

The study was conducted in the Department of Physical Medicine and Rehabilitation (PM & R), Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India in collaboration with Department of Physical Medicine and Rehabilitation (PM & R), Patna Medical College and Hospital, Patna, Bihar, India with facilities for neuroimaging and stroke rehabilitation.

Study Duration

The study was carried out over a period of one year, from March 21, 2024, to February 20, 2025.

Inclusion Criteria

Patients were included if they met the following criteria:

- Diagnosed cases of ischaemic stroke confirmed by clinical assessment and non-contrast computed tomography (NCCT) of the head.
- Patients aged ≥18 years.
- Patients who had given informed consent.
- Patients within the subacute to early chronic phase of stroke (e.g., within 3 months post-stroke).

Exclusion Criteria

Patients were excluded if they had:

- Haemorrhagic stroke or transient ischaemic attack (TIA).
- Pre-existing neurological disorders affecting motor function (e.g., Parkinson's disease, multiple sclerosis).
- Severe cognitive impairment or psychiatric illness interfering with assessment.
- Patients who did not provide consent.
- Patients with recurrent strokes during the study period.
- Poor-quality neuroimaging scans that could not be assessed reliably.

Ethical Considerations

- Approval was obtained from the Institutional Ethics Committee before initiating the study.
- Written informed consent was obtained from all participants.
- The study adhered to the Declaration of Helsinki guidelines.

Study Procedure

1. Data Collection
- Basic demographic data, including name, age, and gender, were recorded.
2. Neuroimaging Assessment (ASPECTS Scoring on NCCT Head)
- Patients underwent NCCT of the head.
- **Alberta Stroke Programme Early Computed Tomography Score** (ASPECTS): Radiological assessment was performed using the ASPECTS score on NCCT of the head by an expert radiologist. Based on the ASPECTS score, patients were divided into two groups [7]:
  - Better ASPECTS group (8–10)
  - Worse ASPECTS group (0–7)

The Worse group was further subdivided into:
  - ASPECTS 0–4 (extensive infarction)
  - ASPECTS 5–7 (moderate infarction)

3. Motor and Functional Assessment

The Fugl-Meyer Assessment (FMA) of motor function is a standardized tool for evaluating post-stroke hemiplegic patients. It assesses motor recovery based on synergistic and isolated

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movement patterns, reflex activity, coordination, and hand grasp. The total score is 100, with 66 points assigned to the upper limb and 34 to the lower limb, providing a comprehensive measure of motor impairment and recovery.[8]

- Fugl-Meyer Assessment (FMA) was used to evaluate motor impairment, divided into three groups.[9]
  - ≤55: Severe to moderately severe impairment
  - 56–79: Moderate impairment
  - >79: Mild impairment
- Barthel Index (BI) was used to assess functional dependence, divided into three groups[10]:
  - 0–20: Total dependence
  - 21–60: Severe dependence
  - >60: Moderate to slight dependence
- Correlation Analysis
- FMA and BI scores were correlated with ASPECTS on NCCT head.
- Patients were categorized based on their ASPECTS scores and analyzed for their respective motor and functional recovery.

Outcome Measures

The primary outcome measures were:

- Fugl-Meyer Assessment (FMA) scores for motor recovery.
- Barthel Index (BI) scores for functional recovery.
- ASPECTS scores on NCCT for radiological assessment.
- Correlation between ASPECTS, FMA, and BI scores.

Statistical Analysis

- Descriptive statistics were used to summarize baseline characteristics.
- Pearson's/Spearman's correlation coefficient was used to assess the relationship between ASPECTS, FMA, and BI.
- Student's t-test / Mann-Whitney U test was used for continuous variables.
- Chi-square test was applied for categorical data.
- A p-value <0.05 was considered statistically significant.

RESULTS

The study included 56 patients aged ≥18 years who were diagnosed with ischemic stroke, comprising 30 males and 26 females.

Table 1: Age and gender wise distribution of the participants

Age group (years)	Male	Female	P value
41-50	5	4	0.05
51-60	10	9	
61-70	7	11	
>70	8	2	
Total	30	26	

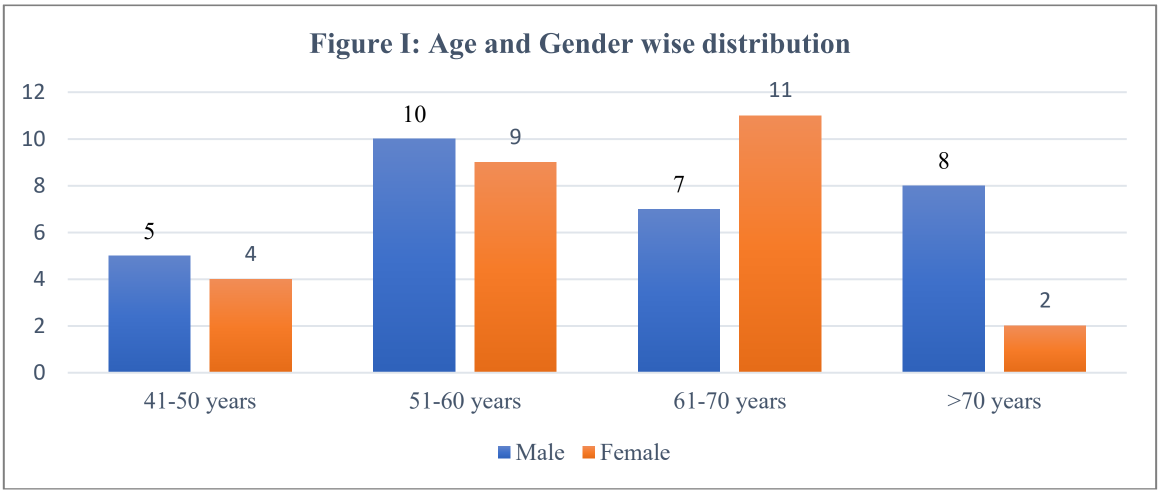

Table 1, figure I shows that age group 41-50 years had 5 males and 4 females, 51-60 years had 10 males and 9 females, 61-70 years had 7 males and 11 females and >70 years had 8 males and 2 females. The higher prevalence of stroke in females in the 61-70 age group may indicate hormonal or vascular risk factors. The higher stroke incidence in males >70 years aligns with

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known cardiovascular risk factors that increase with age.A p-value of 0.05 indicates borderline statistical significance, suggesting a possible relationship between age group and gender distribution in ischemic stroke patients.

Table 2: Assessment of clinical parameters in ischemic stroke patients and their statistical significance in relation to stroke recovery

Parameters	Variables	Number	P value
Duration of stroke	6 months- 2 years	36	0.02
	>2 years	20	
Side	Right	39	0.01
	Left	17	
ASPECTS	0-4	7	0.01
	5-7	22	
	8-10	27	
Barthel Index (BI)	0-20	2	0.01
	21-60	14	
	>60	40	
Fugl-Meyer Assessment (FMA)	<55	20	0.82
	56-79	17	
	>79	19	

Figure II: Assesment of the parameters

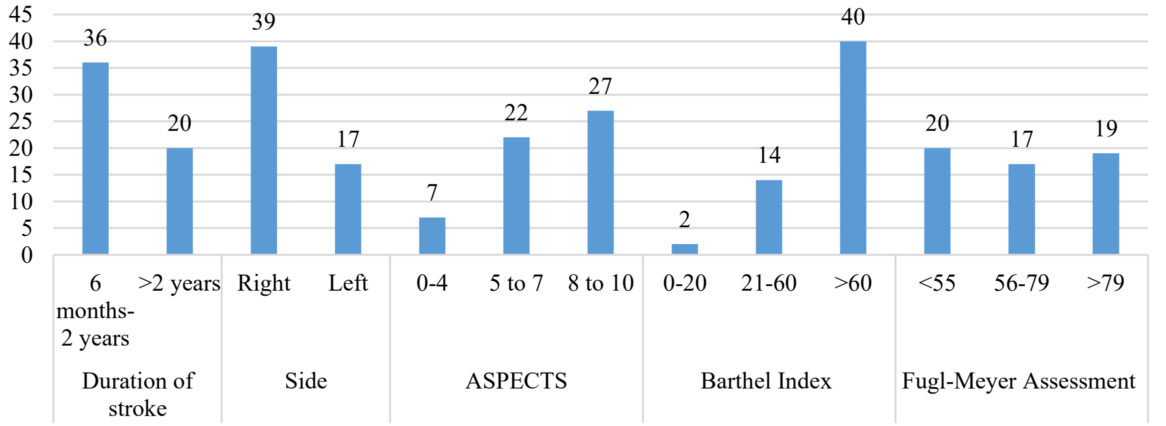

Table 2 and figure II show that 36 patients had stroke duration between 6 months and 2 years. 20 patients had stroke duration of more than 2 years. The statistically significant p-value (0.02) suggests that stroke duration significantly impacts recovery outcomes.

Patients with a shorter duration (6 months–2 years) might have better recovery potential. 39 patients had right-sided strokes, while 17 patients had left-sided strokes. A p-value of 0.01 indicates a significant association between stroke laterality and recovery outcomes. Right-sided strokes (affecting the left body) are more common in this cohort and may influence functional or motor recovery differently from left-sided strokes. ASPECTS score 0-4 4 (severe stroke damage) was seen in 7, 5-7(moderate stroke damage) in 22 and 8-10 (mild stroke damage) in 27. A p-value of 0.01 shows that ASPECTS is significantly related to stroke severity and outcomes. Higher ASPECTS scores (8-10) are associated with better recovery.

Barthel Index (BI) 0-20 (severe disability) was seen in 2, 21-60 (moderate disability) in 14 and >60 (good functional recovery) in 40. A p-value of 0.01 indicates a strong correlation between ASPECTS and functional independence. Patients with higher BI scores have better post-stroke independence in daily activities.

Fugl Meyer Assessment <55 (severe motor impairment) was seen in 20, 56-79 (moderate motor impairment) in 17 and >79 (good motor

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recovery) in 19 patients. The p-value of 0.82 indicates no statistically significant correlation between FMA and other parameters. This suggests that motor recovery (assessed by FMA) may depend on additional factors beyond those included in this analysis.

Table 3: Correlation of ASPECTS with BI, FMA and Ambulatory Status

Parameters		0-4	5-7	8-10	P value
Barthel Index (BI)	0-20	0	2	0	0.01
	21-60	2	9	3	
	>60	5	11	24	
Fugl-Meyer Assessment (FMA)	<55	2	13	5	0.01
	56-79	3	7	7	
	>79	2	2	15	
Ambulatory status	Wheelchair bound	1	4	6	0.01
	Independent with support	3	8	13	
	Independent without support	3	10	8	

Figure III: Correlation of aspects with BI, FMA, Ambulatory status

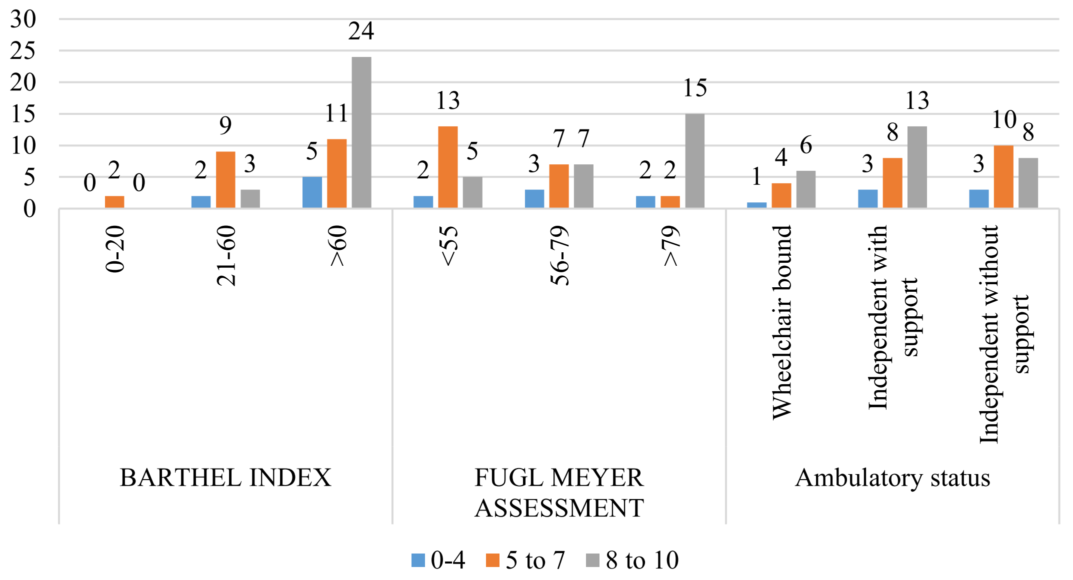

Table 3 and figure III shows that the patients with lower ASPECTS (0-4) mostly had poor functional independence (BI ≤60). Higher ASPECTS (8-10) was associated with better functional independence (24 patients had BI >60). Statistical significance: p = 0.01, indicating a strong correlation.

Lower ASPECTS (0-4) was linked to severe motor impairment (2 patients had FMA <55). Higher ASPECTS (8-10) showed better motor recovery (15 patients had FMA >79). Statistical significance: p = 0.01, suggesting a strong association.

Patients with low ASPECTS (0-4) were more likely to be wheelchair-bound (1 patient) or needed support (3 patients). Those with higher ASPECTS (8-10) had better mobility, with 8 patients walking independently without support. Statistical significance: p = 0.01, confirming a meaningful correlation.

DISCUSSION

The degree of early ischemic changes on neuroimaging has been linked to the functional outcome, and ASPECTS is a valid technique to ascertain the degree of early ischemic changes in stroke.[11] Stroke is a significant global health issue and a primary cause of long-term adult disability. Imaging is essential in evaluating acute stroke and aiding in the decision to begin treatment.[12]The present study was conducted to correlate motor and functional recovery with Neuroimaging in patients with ischaemic stroke.

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We found that age group 41-50 years had 5 males and 4 females, 51-60 years had 10 males and 9 females, 61-70 years had 7 males and 11 females and >70 years had 8 males and 2 females. Females in the 61-70 age group had a higher stroke prevalence. This trend aligns with findings from Appelros et al. (2009), who reported that postmenopausal women have an increased stroke risk due to the loss of estrogen's protective effects on vascular health.[13]

The higher prevalence of stroke in men over 70 years is consistent with findings from Seshadri& Wolf (2007), who noted that older men have a greater burden of cardiovascular risk factors such as hypertension, smoking, and diabetes.[14]

The highest number of strokes occurred in the 51-60 age group (19 patients), indicating that midlife is a critical period for stroke prevention. Studies by Feigin et al. (2016) highlight that stroke incidence increases significantly after the age of 50, and proactive management of risk factors is crucial.[15]

We found that duration of stroke was 6 months-2 years seen in 36 and >2 years in 20. Side was right in 39 and left in 17. Recovery is most pronounced within the first 6 months to 2 years post-stroke, aligning with neuroplasticity theories (Langhorne et al., 2011).[16] Patients who receive intensive rehabilitation within this window show greater motor and functional improvements (Krakauer et al., 2012).[17] Beyond two years, recovery plateaus due to diminishing neuroplasticity and adaptive motor control constraints.

Left-sided strokes (affecting the dominant hemisphere in most patients) are linked with aphasia, cognitive dysfunction, and slower recovery, corroborating prior findings (Karbe et al., 1998).[18]Right-sided strokes impact motor and visuospatial functions, with better motor recovery compared to cognitive deficits.

In present study ASPECTS score 0-4 4 (severe stroke damage) was seen in 7, 5-7 (moderate stroke damage) in 22 and 8-10 (mild stroke damage) in 27. The ASPECTS scoring system is a validated predictor of ischemic stroke severity and prognosis. Higher ASPECTS scores correlate with smaller infarct volumes, better motor function, and improved functional independence (Barber et al., 2000).[4]Lower ASPECTS scores (0-4) are associated with extensive infarction and poor neurological recovery.

We found that Barthel Index (BI) 0-20 (severe disability) was seen in 2, 21-60 (moderate disability) in 14 and >60 (good functional recovery) in 40. Fugl Meyer Assessment <55 (severe motor impairment) was seen in 20, 56-79 (moderate motor impairment) in 17 and >79 (good motor recovery) in 19 patients. The Barthel Index is a well-established tool for assessing functional independence in stroke survivors (Mahoney &Barthel, 1965).[19] Higher BI scores (>60) indicate greater ability to perform daily activities without assistance. Prior studies suggest that FMA improvements depend on stroke location, infarct volume, and post-stroke rehabilitation intensity (Gladstone et al., 2002).[20]

In present study the patients with lower ASPECTS (0-4) mostly had poor functional independence (BI ≤60). Higher ASPECTS (8-10) was associated with better functional independence (24 patients had BI >60). Lower ASPECTS (0-4) was linked to severe motor impairment (2 patients had FMA <55). Higher ASPECTS (8-10) showed better motor recovery (15 patients had FMA >79). Patients with low ASPECTS (0-4) were more likely to be wheelchair-bound (1 patient) or needed support (3 patients).Those with higher ASPECTS (8-10) had better mobility, with 8 patients walking independently without support. Previous studies confirm that higher ASPECTS scores correlate with better functional independence post-stroke (Coutts et al., 2004).[21] A study by Demchuk et al. (2000) found that patients with ASPECTS ≤ 7 had a higher risk of dependency and disability at 3 months post-stroke.[22]

Higher ASPECTS scores indicate smaller infarct volume, allowing for better motor recovery through neuroplasticity and rehabilitative interventions (Cramer et al., 2011).[23] A study by Saposnik et al. (2010) found that patients with higher ASPECTS scores had significantly greater improvements in motor function at 3- and 6-months post-stroke compared to those with lower scores.[24]

A study by Kawahata et al. (2018) found that patients with ASPECTS >7 had a significantly higher probability of regaining independent ambulation within 6 months compared to those with ASPECTS ≤4.[25]

Dhimanet al.[26] correlated the motor recovery and functional outcome with Computed Tomography (CT) brain findings using Alberta Stroke Programme Early Computed Tomography Score (ASPECTS) in patients with ischaemic stroke. The mean age of the study population was 60.98±8.61 years. The mean BI score was

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70.34±25.2, and FMA score was 61.56±32.8. The mean ASPECTS was 7.5, with 26 patients having ASPECTS 8-10 and 19 with ASPECTS 0-7. Patients with higher ASPECTS (8-10) had moderate to no dependence in Activities of Daily Living (ADL) and mild to no motor impairment respectively (p-value <0.0001).

LIMITATIONS OF THE STUDY

1. Small sample size (56 patients) may limit the generalizability of results.
2. Single-centre study, which may not reflect broader population variations.
3. Cross-sectional design, which does not assess long-term recovery outcomes.
4. Limited functional assessment tools (FMA and BI) may not capture all aspects of recovery.
5. NCCT-based ASPECTS scoring, which lacks perfusion-weighted imaging insights.

CONCLUSION

In present study, Authors found that the significant correlation between neuroimaging (ASPECTS) and FMA and BI in ischemic stroke patients. Long-term functional and motor outcomes are positively correlated with higher ASPECTS at stroke start. A higher ASPECTS score (8-10) was associated with better motor function (FMA > 79), greater independence (BI > 60), and improved ambulatory status. Stroke duration, lesion laterality, and ASPECTS significantly influenced recovery outcomes (p = 0.01). Patients with prolonged stroke duration (>2 years) and lower ASPECTS (0-4) had worse functional outcomes, emphasizing the importance of early neuroimaging assessment and timely rehabilitation. In order to improve the functional outcome, prevent complications, and assist stroke survivors in becoming more independent in their everyday activities, ASPECTS can be used to plan rehabilitation interventions based on the patients' anticipated recovery and to set realistic goals on an individual basis early on.These findings reinforce ASPECTS as a valuable prognostic tool in stroke management.

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