



## To Study the Relationship Between Various Functional Outcome And Neuro-Imaging in Acute Ischemic Strokes

### KEYWORDS

risk factors in stroke, arterial territory in acute stroke, neuroimaging, barthel index score, modified rankin scale score, acute ischemic stroke

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**ABSTRACT** **Introduction** A more than one third of stroke survivors are left with permanent disability in the form of significant residual physical, cognitive and psychological impairments. Accurate outcome prediction following stroke is important for the proper delivery of post stroke care and establishment of an effective continuing care program. In this study we have tried to find out the relationship between various functional outcome and neuroimaging in acute ischemic strokes.

**Methodology** Study was conducted at a tertiary care centre in over a period of 1 years. Patients detected to have acute stroke were evaluated at enrolment (within 7 days from stroke onset) and during follow up at 12 weeks after stroke by the same observer. All the patients were given standard care as per the guidelines of American Stroke Association. Primary outcome was to assess the functional outcome in acute ischemic stroke at the end of 12 weeks and to study the correlation between the functional outcome scales and findings on neuroimaging of brain.

**Results** Sixty nine patients were screened for the study and 58 patients met the eligibility criteria. Out of 58 patients, 8 patients had presented within window period (3h – 4 1/2 h). The overall mortality during 12 weeks amounted to 10.3% and was higher in men (6.9%) than women (3.4%). Infarct size and BI score at admission, 4 weeks and at 12 weeks were found to be negatively correlated ( $p < 0.001$ ) which means that as the infarct size increased, BI score decreased. Similarly, infarct size and MRS score at admission and at follow up was positively correlated Patient ( $p < 0.001$ ). Stroke with smaller ( $< 3$  cm<sup>3</sup>) infarct size had better outcome than larger infarct ( $> 3$  cm<sup>3</sup>) i.e 44.4% vs 3.7% using BI (BI $>90$ ) and 94.4% vs 55 % using MRS score (MRS  $\leq 3$ ).

**Conclusion** The infarct size and BI score at admission and at follow up was negatively correlated and infarct size and MRS score at admission and at follow up was positively correlated. The functional outcome of the anterior circulation stroke was better as compared to the posterior circulation stroke. All the modifiable risk factors except Type 2 Diabetes Mellitus had adverse impact in the functional outcome.

### INTRODUCTION

After Coronary Artery Disease (CAD) and cancer of all types, stroke is the second commonest cause of death worldwide.<sup>1</sup> In most parts of the world about 70% of strokes are due to ischemia, of which 25% are cardio embolic. Rest 27% are haemorrhagic and 3% are of unknown cause.<sup>2</sup> The definition of stroke is clinical, and laboratory studies including brain imaging are used to support the diagnosis. The clinical manifestations of stroke are highly variable because of the complex anatomy of the brain and its vasculature. Immediate CT scanning is the most cost effective strategy for imaging acute stroke patients<sup>3</sup>, but is not sensitive for old haemorrhage. Outcomes reported in stroke trials include impairments, disability, handicap, and quality of life. Clinical outcome can be classified into (a) impairment (signs of underlying pathology), (b) disability (the functional results of impairment) and (c) handicap (the social impact of the disease).<sup>4</sup> Construct validity of the MRS has been affirmed by multiple studies in which it has been consistently observed that the location, type and extent of stroke injury are closely related to short and longer term disability.

### MATERIALS AND METHODS

1. Study was conducted at a tertiary care center western India from Dec 2009 to Dec 2010.
2. The stroke risk factors were noted in every patient.
3. Informed consent was taken from each patient/patient's next of kin (NOK), enrolled in study.
4. The diagnosis of stroke due to vascular event was

confirmed in each case by neuroimaging (plain CT Scan Head/MRI Brain) apart from the clinical evaluation.

5. Patients screened were evaluated at enrollment (within 7 days from stroke onset) and during follow up at 12 weeks after stroke by the same observer employing the same criteria used at the time of presentation using following scales.
  - (a) Modified Rankin Scale (mRS)
  - (b) The Barthel's index (BI)
6. All the patients were given standard care as per the guidelines of American Stroke Association.
7. The outcome was to study the correlation between the functional outcome scales and findings on neuroimaging.
8. Statistical analysis using SPSS statistical software package version 11.0 (SPSS Inc, Chicago IL, USA) was carried out.

### 9. Inclusion criteria

All ischemic stroke patients  $> 18$  yrs of age.  
All cases of acute ischemic stroke  $< 7$  days duration.

### 10.Exclusion criteria

Transient Ischemic Attack (TIA).  
Intracranial/ Subarachnoid Haemorrhage (ICH/SAH).  
Seizures.  
Head injury.  
Recurrent stroke.  
Other causes of focal neurological deficits.

## RESULTS

A total number of 69 patients were screened for the study and 58 patients met the eligibility criteria and were taken for the same. 11 patients did not meet the eligibility criteria, out of which 1 had TIA, 1 had seizure, 8 had haemorrhagic stroke and 1 had recurrent stroke. Out of 58 patients, 8 patients had presented within window period (3h-4 <sup>1/2</sup>h). The overall mortality during 12 weeks amounted to 10.3% and was higher in men (6.9%) than women (3.4%). The mean age of study population was 57.10 + 12.54. The mean age of males was 58.16 + 12.07 years and that for females was 54.31 + 13.07 year.

Four modifiable risk factors were analysed in this study. They are Diabetes mellitus, Hypertension, Dyslipidemia and Smoking. The various risk factors of the study population are depicted in the following table according to different age groups. The risk factors except for Type 2 Diabetes mellitus were found to be significantly.

Age Group	Sex*		DM		HTN*		Dyslipidemia*		Smoker*	
	M	F	Yes	No	Yes	No	Yes	No	Yes	No
<30	2 (4.8)	1 (6.3)	-	3 (7.3)	-	3 (8.8)	-	3 (5.8)	-	3 (6.7)
31-40	-	3 (18.8)	-	3 (7.3)	-	3 (8.8)	-	3 (5.8)	-	3 (6.7)
41-50	7 (16.7)	2 (12.5)	2 (11.8)	7 (17.1)	1 (4.2)	8 (23.5)	-	9 (17.3)	1 (7.7)	8 (17.8)
51-60	11 (26.2)	3 (18.8)	2 (11.8)	12 (29.3)	9 (37.5)	5 (14.7)	1 (16.7)	13 (25.0)	5 (38.5)	9 (20.0)
61-70	18 (42.9)	3 (18.8)	10 (58.8)	11 (26.8)	10 (41.7)	11 (32.4)	1 (16.7)	20 (38.5)	5 (38.5)	16 (35.6)
>70	4 (9.5)	4 (25.0)	3 (17.6)	5 (12.2)	4 (16.7)	4 (11.8)	4 (66.7)	4 (7.7)	2 (15.4)	6 (13.3)
Total	42 (100)	16 (100)	17 (100)	41 (100)	24 (100)	34 (100)	6 (100)	52 (100)	13 (100)	45 (100)

The frequencies and percentage of modifiable risk factors are given in Table 1. Seventeen (29.3%) had diabetes mellitus, 24(41.4%) had hypertension, 6 (10.3 %) patients had dyslipidemia and 16 (27.6%) patients were smokers.

**Table 1: Association of risk factors of Ischemic stroke in different age groups**

\*P (Chi square trend) <0.05

### Prevalence of Type 2 Diabetes Mellitus according to age group

Seventeen (29.3%) of stroke patients were T2 DM on presentation while 41 (70.7%) patients were not having T2 DM and the difference between them were found to be not significant (p=0.163). Out of 17 stroke patients with T2 DM, 16 (94.17%) patients using BI and 9 (52.9%) patients using MRS score had poor functional outcome at 12 weeks but were statistically not significant.

### Prevalence of Primary hypertension according to age group

Twenty four (41.4%) of stroke patients were hypertensive while to 34 (58.6%) were normotensive and the difference between them were found to be significant (p<0.05). Out of 24 hypertensive patients, 22 (91.7%) patients using BI and 14 (58.3%) patients using MRS score had poor functional outcome at 12 weeks. The difference between the

outcomes however was not significant.

### Prevalence of Dyslipidemia according to age group

Six (10.3%) patients with dyslipidemia and 52 (89.6%) patients with normal lipid profile developed stroke. The difference between them were found to be significant (p<0.05). All patients (100.0%) having dyslipidemia had a poor functional outcome at follow up by using both BI (p = 0.581). Five (83.3%) patients had poor functional outcome by using mRS score and the difference was found statistically significant (p=0.012).

### Distribution of smoker according to age group

Thirteen (22.4%) stroke patients were smokers compared to 45 (77.5%) patients who were non-smokers (p<0.05).

All patients (100.0%) who were smokers had very poor functional outcome at follow up by using both BI (p=0.178) (Table 8). Nine (69.2%) smoker patients had poor functional outcome by using mRS score and the difference was found to be significant (p<.005).

### Correlation between infarct size and the functional outcome using BI and mRS scores

The infarct size was noted from the initial MRI and the correlation between the volume of infarct and functional outcome were examined at admission and during 12 weeks follow up by using both Barthel index and the Modified Rankin Scale (mRS) scores.

**Table 2: Correlation between infarct size and the functional outcome**

		BI at admission	BI at 4 weeks	BI at 12 weeks	MRS at admission	MRS at 4 weeks	MRS at 12 weeks
	N	58	58	58	58	58	58
Infarct size	Pearson Correlation	-.575	-.719	-.773	.577	.656	.436

Infarct size and BI score at admission, 4 weeks and at 12 weeks were found to be negatively correlated (p<0.001) which means that as the infarct size increased, BI score decreased. Infarct size and MRS score at admission, 4 weeks and at 12 weeks were found to be positively correlated (p<0.001) which means that as the infarct size increased, MRS increased. Out of 58 patients 18 (31.0%) had infarct size < 3 cm<sup>3</sup> and 40 (69.0%) had infarct size >3 cm<sup>3</sup> (p<0.001).

**Table 3: Size of infarction according to arterial territory**

Sl no	Site	Size		Total
		< 3 cm <sup>3</sup>	>3 cm <sup>3</sup>	
1	LMCA	9(15.5%)	16(27.6%)	25(43.1%)
2	RMCA	7(12.1%)	15(25.9%)	22(37.9%)
3	LICA	-	4(6.9%)	4(6.9%)
4	PCA	2(3.4%)	5(8.6%)	7(12.1%)
5	Total	18(31.0%)	40(69.0%)	58(100.0%)

### Correlation between the size of infarct and functional outcome using BI

Out of 18 patients with infarct size < 3 cm<sup>3</sup>, 8 (44.4%) had good outcome and 10 (55.6%) had poor outcome. In 40 patients with infarct size > 3 cm<sup>3</sup>, 3 (7.5%) had good outcome and 37 (92.5%) had poor outcome (p= 0.003).

### Correlation between the size of infarct and functional outcome using mRS

Out of 18 patients with infarct size  $< 3 \text{ cm}^3$  17 (94.4%) had good outcome and 1(5.6%) had poor outcome. In 40 patients of larger infarct ( $>3 \text{ cm}^3$ ), 22 (55%) patients had good outcome and 18 (45%) had poor outcome ( $p=0.003$ ).

### Site of infarct and functional outcome

Fifty one patients (88%) had anterior circulation stroke. Out of which, 25 (43 %) patients related to left middle cerebral artery (LMCA), 22 (38%) patients were related to right middle cerebral artery (RMCA) and 4 (7%) of them were related to left internal carotid artery (LICA) territory infarction. Posterior circulation territory was related to 7 (12.0%) patients, of which, 6 (10%) had brainstem infarct (midbrain & pons), and 1 (2%) had infarct in the cerebellum.

**Site of infarct at presentation** Out of 58 patients 51(88%) had presented with motor weakness in the form of hemiparesis. Twenty nine 29 (50%) had right sided (LMCA (25%) and LICA (4%)) weakness and 22 (38%) had left sided (RMCA) motor weakness. Rest 7 (12 %) patients presented with giddiness/ataxia/altered sensorium (PCA).

**Table 4: Distribution of patients as per type of weakness**

Right hemiparesis		Left hemiparesis	Gait ataxia/altered sensorium	Total
LMCA	LICA	RMCA	PCA	
25(43%)	4 (7%)	22 (38%)	7(12%)	58(100%)

### Site of infarct and functional outcome at 12 weeks using mRS score

By using Modified Rankin Scale score (MRS  $<3$ ), out of 51 patients of anterior circular stroke, 31(60.8%) patients had good outcome and 20(39.2%) patients had poor outcome ( $p=0.38$ ). Amongst 7 patients of posterior circulation strokes, 4 (57.1%) patients had good outcome and 3 (42.9%) patient had poor outcome ( $p=0.38$ ).

### DISCUSSION

Specifying a favourable outcome in acute stroke is difficult, because most outcomes form a continuum. Since the length of hospital stay varies enormously both among hospitals and among patients in a given hospital, the measurement of functional status at discharge can result in faulty conclusions.<sup>5</sup> To avoid these difficulties, we measured functional status at 04 and 12 weeks after the stroke, regardless of where the patient was at that time (i.e., hospital, home, or rehabilitation centre).

The Barthel Index is a widely used ADL scale that comprises 10 weighted items measuring feeding, bathing, grooming, dressing, bowel control, bladder control, toileting, chair/bed transfer, ambulation, and stair climbing.<sup>6</sup> The original BI was scored in steps of five points to give a maximum total score of 100. The score of the BI is a summed aggregate and there is preferential weighting on mobility and continence. The scores are allotted in the following way: 0 or 5 points per item for bathing and grooming; 0, 5, or 10 points per item for feeding, dressing, bowel control, bladder control, toilet use, and stairs; 0, 5, 10, or 15 points per item for transfers and mobility. The Index yields a total score out of 100, the higher the score, the greater the degree of functional independence.<sup>7</sup>

The Modified Rankin Scale (mRS) is the most popular clinician-reported measure of global disability that has been widely applied for evaluating recovery from stroke assess-

ment.<sup>8,9</sup> In the mRS: grade 1 of the original RS ("no significant disability") is replaced by 2 grades, 0 and 1, with grade 0 describing patients without symptoms and grade 1 describing patients without significant disability "despite symptoms."

The Modified Rankin Scale and the Barthel Index are the two traditional functional outcome assessment tools in stroke survivors. To measure post stroke disability, researchers and practitioners often use basic ADL measures. This study showed the relationship among widely used post stroke ADL measures and a global disability measure. To see the trend of the stroke outcome in our centre we undertook a study with 58 patients of acute ischemic stroke. It was an almost similar to the study carried out by Sooyeon Kwon, MS; Abraham G.Hartzema, PhD; Pamela W. Duncan, PhD; Sue-Min Lai, PhD, who analyzed the relationship among Barthel Index, Modified Rankin Scale and functional Independence measure in assessing the disability measure in stroke<sup>10</sup>.

In our study it was found that the BI score at baseline correlated with the BI score at 12 weeks and similarly MRS score at baseline correlated with the MRS score at 12 weeks, had a positive correlation ( $p<0.001$ ). Whereas the Barthel Index at admission and on follow up correlated with the MRS at admission and on follow up showed a negative correlation ( $p<0.001$ ), meaning that as the MRS increased the BI decreased. A similar findings observed by Sooyeon Kwon, MS; Abraham G.Hartzema, PhD; Pamela W. Duncan, PhD; Sue-Min Lai, PhD.<sup>10</sup>

Other study by MM Paithankar and RD Dabhi in which functional recovery was assessed in ischemic stroke with relation to infarct size. The total duration of follow up in this study was 3 months. It was also noticed that significant neurological recovery occurred in the initial 3 to 4 weeks after stroke. Total 74 patients of ischemic stroke were studied. In our study we used both scales as base line to assess the functional outcome. The total duration for assessing the outcome was 12 weeks ( $\approx 3$  months). Total no of patients in our study was 58, almost similar to the study conducted by MM paithankar and RD Dabhi.

Hypertension is the single most important risk factor for all types of stroke: ischemic stroke, intra cerebral haemorrhage, and aneurysmal subarachnoid haemorrhage. Epidemiologic studies over the past 30 years have demonstrated a dramatic reduction in the incidence and mortality of all stroke types with good control of hypertension, and it appears that all effective antihypertensive agents have similar efficacy in their ability to reduce stroke risk. In addition, it appears that acute treatment of hypertension in the setting of intra cerebral haemorrhage and subarachnoid haemorrhage is beneficial, but it is still uncertain in the setting of ischemic stroke what level of blood pressure will result in the best possible outcome.<sup>11</sup> In our study out of 24 hypertensive patients 22 (91.7%) patients using BI score and 14 (58.3%) patients using MRS score had poor functional outcome.

Smoking correlated with higher NIHSS scores on admission for small-vessel occlusion.<sup>12</sup> Our study observed that, all 13 (100.0%) patients who were smoker had very poor functional outcome at follow up by using both BI score and nine (69.2%) smoker patients had poor functional outcome by using MRS score.

Compared with non diabetic stroke patients, patients with T1DM or T2DM were more likely to have hyperten-

sion and stroke attributable to small vessel disease. In addition, when compared with non diabetic patients, those with T2 DM more often had obesity, Peripheral arterial disease (PAD), history of TIA, and stroke attributable to large-artery atherosclerosis, and T2 DM patients were also more likely to be older and male than were the non diabetic patients.<sup>13</sup> However our study did not show any adverse outcome amongst people who are diabetic at the time of presentation. Similar results were obtained by Fiorelli.<sup>14</sup> It was also observed in our study that, risk factor like dyslipidemia was associated with poor outcome.

However the presence of diabetes and hypercholesterolemia was not significantly associated with poor recovery. The significant neurological correlation of outcome was seen with initial neurological scoring.<sup>15</sup>

There was no significant difference in the functional outcome between the internal carotid artery territory infarct and posterior cerebral arterial territory infarct. Johan<sup>16</sup> however found out a significant better outcome prognosis in posterior circulation stroke. Patient with larger infarct had a poorer outcome.<sup>17,18</sup>

In our study, the functional outcome was studied by both BI and MRS scoring system. It is observed that the infarct size was negatively correlated with the functional outcome, meaning patient with larger infarct had poorer outcome. Similar result obtained by Beioosesky Y, Streifler JY and Olsen TS.<sup>17</sup>

In our study, the anterior circulation stroke had better outcome than posterior circulation stroke i.e 19.6% vs 14.3% using BI score (BI>90), and 60.8% vs 57.1% using Modified Rankin Scale score (MRS <3). It was also observed that the RMCA territory stroke had slightly better outcome as compared to LMCA territory stroke i.e 22% vs 20% using BI (BI>90) and 68% vs 64% using MRS score (MRS <3).

Patient with smaller infarct (<3 cm<sup>3</sup>) had better outcome than larger infarct (>3 cm<sup>3</sup>) i.e 44.4% vs 3.7% using BI (BI>90) and 94.4% vs 55 % using MRS score (MRS ≤3). A study conducted by MM Paithankar & RD Dabhi<sup>19</sup> the outcome in smaller infarct (<3 cm<sup>3</sup>) vs larger infarct (>3 cm<sup>3</sup>) was 76.4% vs 64.2% similar to our study.

## CONCLUSION

The infarct size and BI score at admission and at follow up was negatively correlated and infarct size and mRS score at admission and at follow up was positively correlated. The functional outcome of the anterior circulation stroke was better as compared to the posterior circulation stroke. All the modifiable risk factors except Type 2 Diabetes Mellitus had adverse impact in the functional outcome.

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