ORIGINAL ARTICLE

STROKE OUTCOME PREDICTION USING ADMISSION NIHSS IN ANTERIOR AND POSTERIOR CIRCULATION STROKE

Sahrish Aieshah Kazi, Maimoona Siddiqui, Sadaf Majid

Shifa College of Medicine and Shifa International Hospital, Islamabad-Pakistan

Background: Stroke is a worldwide disease with high morbidity. Various scales are used to measure the severity and outcome of stroke. National Institute of Health Stroke Scale (NIHSS) is a quantifiable scale used to assess stroke severity. However, it is biased towards anterior circulation stroke as compared to posterior circulation stroke, giving higher values in the former. Therefore, it is imperative to know the mean values of NIHSS in each group to predict the functional outcome. The main aim of the study is to compare the mean NIHSS at the time of admission for determining favourable and unfavourable functional outcome in anterior and posterior circulation ischemic stroke. **Methods:** It is a descriptive case study of six months' duration done in a Tertiary Care Hospital. All patients of 18 years and above with ischemic stroke involving single arterial territory presented in hospital within 72 hours were included. With the help of the WHO sample size calculator, a target population of 100 patients was determined with a confidence level of 95%. For mean difference we applied independent t test and t score with mean differences for NIHSS at admission and location of stroke has been calculated. Patients with haemorrhagic stroke, venous stroke secondary to Dural Sinus thrombosis, with concomitant disability because of any reason including previous stroke, stroke involving watershed areas and concomitant Acute Coronary Syndrome were excluded. A favourable outcome was defined as Modified Ranking scale score of ≤3 at 1-month post stroke. **Results:** In anterior circulation, mean baseline NIHSS was 11.3 [SD 7.4], while in posterior circulation, mean NIHSS was 7.30 [SD 7.6]. Comparing the means for functional outcome in anterior circulation using independent t test score, a lower baseline NIHSS score was independently predictive of a favourable outcome for patients with AC (OR 1.268, 95% CI 1.76 –1.358) and PC (OR 1.534, 95% CI 1.321–1.891) stroke. **Conclusion:** The mean NIHSS of good functional outcome group is much lower for posterior circulation stroke as compared to anterior circulation stroke which highlights the need for basing the decision of acute stroke emergency management on full neurological examination, rather than a single scale, especially if the posterior circulation stroke is in question.

Keywords: Cerebrovascular; Magnetic Resonance Angiography; Magnetic Resonance Imaging; Prospective Studies; Stroke/classification; Stroke/diagnosis; Stroke/drug therapy

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INTRODUCTION

Stroke is a formidable foe. Approximately 795,000 strokes occur annually in the United States of which 20% of the patients will die within the first year after the onset of the stroke. With the current situation, this number might rise up to 1 million per year by the year 2050. One of the leading causes of disability, stroke occurs amongst all age groups, including newborns, children, young adults, and older adults.[1]

Stroke is an underrated cause of death and morbidity in our part of the world. The incidence and mortality of stroke is higher in Asian countries than Western countries.[2] A prospective study conducted by Dalal *et al* at Mumbai observed an annual rate of primary stroke in adult population to be 145/100,000. The mortality was 29.8% at 28 days, and of the survivors, 38.5% had moderate to severe disability on modified Rankin scale. Very little data is available regarding epidemiology of stroke in Asia. The risk of stroke has increased by 100% in low- and middle-income countries over the last decade while the developing world accounts for 85.5% of mortality due to stroke related deaths worldwide.[3] Population-based studies from South Asia have revealed a prevalence of 45–471 per 100,000.[4]The age-adjusted incidence rate varied from approximately 145 per 100,000 to 262 per 100,000. Rural parts of South Asia have a lower stroke prevalence compared to urban areas.[4] In Korea, the overall prevalence and incidence of stroke was 2.08 cases per 100,000 adolescents per year.[5]

No large-scale epidemiological studies are available in a developing country like Pakistan to determine the true incidence of stroke. Estimated annual incidence is 250/100,000, amounting to 350,000 new cases every year.[6] In comparison to

existing worldwide literature on stroke prevalence, the prevalence of stroke in Pakistan is almost twice the highest reported in the world to date.[7]

There are various scales to assess the severity of stroke as well as to gauge the functional outcomes.[8] National Institute of Health Stroke Scale [NIHSS] is an internationally recognized 11-point scale, validated and reproducible, that is applied to estimate the severity of stroke.[9] It gives a score of 0–42. Greater the score, more sever the stroke. It can also be used as a tool to predict the discharge destination[10] as well as mortality[11]. According to a study carried out in University of California, mean NIHSS was determined to be 8.01 [SD=7.88] for acute ischemic stroke and 16.85 [SD 9.18] for death within 30 days.[11] However, it has its own set of shortcomings. There is little inter-rater reliability in some of its evaluation points. It is complex and difficult for non-neurologists to understand which also make it time consuming. It favours left hemispheric stroke more than right hemispheric stroke.[12] Similarly it is biased for anterior circulation [AC] than for posterior circulation [PC] stroke.[12,13] This leads to the false belief that posterior circulation stroke has a better functional outcome than anterior circulation stroke.

These results have raised a dilemma that whether it is justifiable to compare the severity of AC and PC stroke by NIHSS. Therefore, we conducted a prospective study at our center to investigate the validity of NIHSS in predicting a favourable chronic functional outcome in stroke patients as we don't have local data to justify the above fact. A low baseline NIHSS score was independently predictive of a favourable outcome in both patients with PC [OR 1.547, 95% CI1.232–1.941] and AC [1.279, 1.188–1.376] stroke. The baseline NIHSS for a favourable functional outcome in anterior circulation stroke was 4 [Interquartile range 3–7] while for posterior circulation, it was 3 [Interquartile range 1–5].[12]

The aim of this study was to find out the mean NIHSS in ischemic stroke patients and the mean NIHSS for determining a favourable functional outcome in anterior and posterior circulation stroke which would allow us to explore the expected outcome in patients of acute ischemic stroke in Asian Population.

MATERIAL AND METHODS

A prospective descriptive study was conducted at Shifa International Hospital Islamabad which is a tertiary care Hospital with 500 beds. The total study period was six months from December 2018-May 2019 which included data collection, literature review and data analysis. With the help WHO calculator sample size has determined target population of 100 patients with 9% margin of error, a confidence level 95% and <0.005 as significant p value, the age-adjusted incidence rate varied from approximately 145 per 100,000 to 262 per 100,000[4].

Using a consecutive [non-probability] sampling technique all patients who were admitted in the neurology and medical departments of the hospital with the diagnosis of acute stroke were checked for the following criteria.

Inclusion criteria:

1. Age of 18 years or more.
2. Patients with acute stroke following single arterial territory, presenting within 72 hours of onset of signs and symptoms as mentioned in the operational definition.

Exclusion criteria:

1. Patients with haemorrhagic stroke as NIHSS is designed for ischemic strokes only.
2. Patients with venous stroke secondary to Dural Sinus Thrombosis as these strokes do not follow an arterial territory.
3. Patients with a history of a previous stroke - since this would lead to underlying disability.
4. Patients with underlying disability due to any cause because that would be a confounding factor.
5. Patients with concomitant acute coronary syndrome since that would add in morbidity.
6. Patients with watershed area infarcts - because not all of them follow a single vascular territory.

After taking informed written consent from all patients/ next of kin for enrolment, all patients presenting to Shifa international hospital and meeting the inclusion criteria were included in the study. These patients were initially managed according to the "stroke pathway" developed by a multidisciplinary team of our hospital, according to which, the preliminary assessment included determination of NIHSS score, basic investigations including at least one head imaging study and thereafter the patients were managed according to the parameters defined. The pathway followed the current guidelines of acute stroke care according to AHA Stroke guidelines. Baseline NIHSS was done at admission and patients were divided into two groups according to the location of stroke. Modified Rankin scale was done at 1-month post-stroke by clinical follow-up through OPD visit or by a telephone call. Patient or next kin was asked questions regarding patient's daily routine and his improvement like either he is able to perform his basic tasks and what are the tasks in which he was needed assistance, so that we could calculate Modified Ranking Scale. If the patient expired post

stroke before 1 month, he/she was awarded 6 and included in the data. NIHSS and mRS were performed by the trainee researcher. All this data was entered on data collection form. Baseline data was collected for all eligible patients including age, gender, NIHSS and mRs at admission and discharge, location of stroke and outcome entered and analysed using SPSS version 18.0. A favourable outcome was defined as Modified Ranking scale score of ≤3 at 1-month post stroke.

Independent t test applied to compare means for NIHSS admission in Anterior and Posterior circulation and also multivariate favourable and unfavourable outcome in both anterior and posterior circulations, while for quantitative data we took mean and standard deviation.

RESULTS

Out of the 100 patients who were enrolled in the study 67% percent patients presented with anterior circulation stroke while 33% patients presented with posterior circulation stroke. Sixty-five were males and thirty-five were females with male to female ratio is 1.8:1. The mean age of the patients was 65.38±10.6 years (Range 39–90 years) (Figure-1) with range of 90–39 years. The mean baseline NIHSS of the entire patient population was 9.98±7.68 (Range 1–32) [Table-1]

In posterior circulation, mean baseline NIHSS was 7.30 with SD of 7.6 which was lower than anterior circulation, which had the mean baseline NIHSS 11.3 with SD of 7.4 [Table 1]. Analysing each territory separately, favourable functional outcome was seen in 52.2% of patients with anterior circulation stroke and 48.5% of posterior circulation stroke (figure-2). The sensitivity of a baseline NIHSS score ≤5 in favourable functional outcome is 61% (95%Cl 51-71%) and specificity 80% (78-91%) in AC stroke and the sensitivity of baseline NIHSS score ≤8 of PC stroke is 89.9% (95% Cl 79–93%) and specificity was 45%. Compared patients with AC stroke, the unadjusted OR for the mRS score of 0–3 in patients with PC stroke was 2.21 (95% CI 1.29–4.02, *p*-0.002), and the multivariate-adjusted OR was 2.45 (95% CI 1.44–4.204, *p*-0.004).

Comparing the means for functional outcome in anterior circulation using independent t test score, a lower baseline NIHSS score was independently predictive of a favourable outcome for patients with AC (OR 1.268, 95% CI 1.76 – 1.358) and PC (OR 1.534, 95% CI 1.321–1.891) stroke.

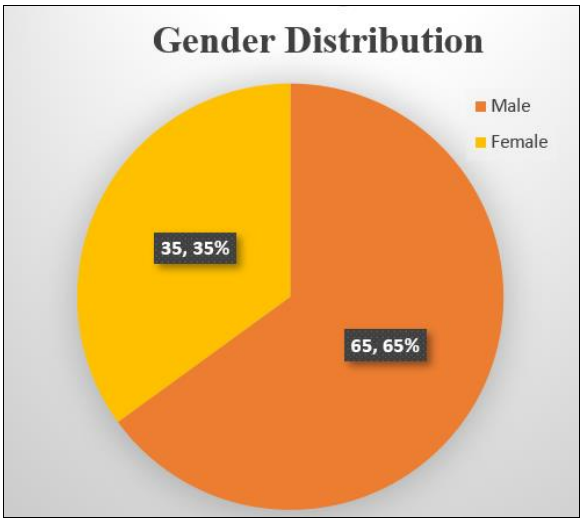

Figure-1: Gender distribution among patients

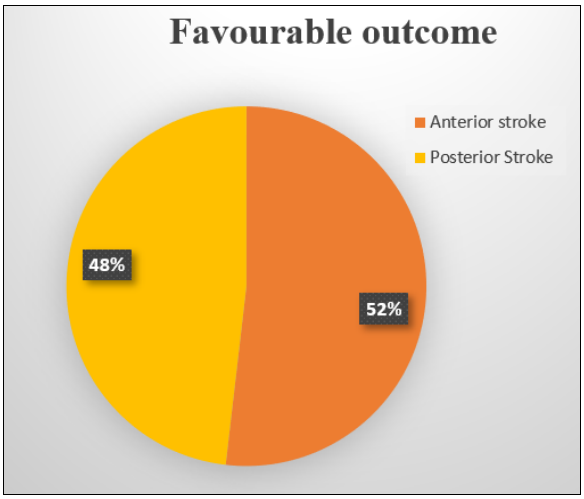

Figure-2: Graph representing Favorable outcome with mRs ≤3 in Anterior circulation stroke and Posterior circulation stroke

Table-1: Mean and Range of NIHSS in Stroke Patients

	N	Minimum	Maximum	Mean	SD
All Ischemic Strokes	100	1	32	9.98	7.682
Anterior Circulation	67	1	32	11.30	7.42
Posterior Circulation	33	1	28	7.3	7.6

DISCUSSION

In this study we compared the mean NIHSS at the time of admission for determining favourable and unfavourable functional outcome in anterior and posterior circulation ischemic stroke.

Stroke is a neurological emergency which calls for timely diagnosis, and management. The decision to intervention relies heavily on the severity as well as the location of stroke. The main purpose of this study is to explore whether our tools of assessment are sufficient and up to the mark? Is it legit to use one yardstick, one parameter? The results of this study tell differently.

One of the major conclusions that can be drawn from this study is that the mean NIHSS for good functional outcome differed in anterior and posterior circulation strokes, and patients with posterior circulation stroke has a higher probability of a bad functional outcome even at lower NIHSS score. In anterior circulation strokes the mean NIHSS of a favourable outcome population is higher than that for posterior circulation. In fact, the mean NIHSS in posterior circulation's bad functional outcome is approaching the anterior circulation's good functional outcome. In a study of 310 patients in which anterior and posterior circulation NIHSS were compared for predicting functional outcome, the 101 patients with PC stroke had low baseline NIHSS score [$p \leq 0.005$]. For patients with AC stroke, the sensitivity of a baseline NIHSS score ≤5 to predict a favourable outcome was 65% (95% CI 55–73%), and the specificity was 89% (81–95%) while for patients with PC stroke, the sensitivity was 93% (85–98%) and the specificity of a baseline NIHSS ≤8 to predict a favourable outcome was 46% (95% CI 27–67%).[12] This finding is very similar to our results in which the sensitivity of a baseline NIHSS score ≤5 in favorable functional outcome is 61% (95% Cl 51–71%) in AC stroke and the sensitivity of baseline NIHSS score ≤8 of PC stroke is 89.9% (95% Cl 79–93%).

These differences have their obvious underlying reasons. NIHSS is an 11-point score. Out of these speech and language, face and neglect are anterior circulation function only. Motor functions, also, are affected mainly by anterior circulation stroke.[12,13] On the contrary, visual field defect and limb ataxia are the only pure manifestations of posterior circulation stroke, with a small number of patients having facial involvement, and motor weakness. Ataxia is often excluded from the examination owing to the motor weakness of the limb.

Many important features of posterior circulation like nystagmus, dysphagia, anisocoria, and gait are not considered at all in this scale. This weakness of the measuring tool isn't limited to NIHSS but also holds true for modified Rankin scale, which assesses motor functions more.

Such limitations of NIHSS have their own implications. Thrombolysis with IV tissue plasminogen activator is the treatment of choice for patients presenting within 3 hours of symptom onset. Many important studies had a cut-off of 4 on NIHSS for thrombolysing the patients.[14] Any stroke scoring below 4 on NIHSS will not be thrombolysed. Our study's mean NIHSS in posterior circulation patient with good functional outcome is 3, which is very close to 4. For this very reason, this scale alone should not be utilized for taking the decision of thrombolysis and clinical parameters, not covered in this scale, should be considered.

There are few limitations in the study. First, all the patients did not undergo MR imaging owing to which, there is a chance that small/lacunar infarcts are missed. Secondly, patients who did not come for follow up after one month were called on phone to assess modified Rankin scale. This could have resulted in an over or underestimation of the functional outcome as the patient was not physically present for direct observation.

Moreover, since this is a single institution, in-patient based study, its results cannot be applied ~~on~~to a larger population. However, it does highlight the need to have certain parameters added in the currently used stroke scale, or employment of a different scale for posterior circulation stroke, especially when sensitive decisions like thrombolysis have to be made.

CONCLUSION

National institute of health stroke scale is a validated and reliable tool to assess the severity of stroke. However, its score should be interpreted critically keeping in mind that it tends to underestimate the severity of posterior circulation stroke. Therefore, decision about emergency management of acute stroke should be based on full neurological examination, rather than a single scale, especially if the posterior circulation stroke is in question

Conflict of interest:

There is no conflict of interest of any other.

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Data Availability Statement:

The SPSS Sheet (version 18) of data used to support the findings of this study are available from the corresponding author upon request.

AUTHORS' CONTRIBUTION

SAK: Concept and design, data collection, data analysis, write-up, review. MS: Concept and design, data analysis, write-up, review and editing. SM: Data collection, data analysis, review and editing.

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Address for Correspondence:

Dr. Sadaf Majid, Shifa International Hospital, Neurology Division, Pitrus Bukhari Road, H-8/4, Sector H. Islamabad-Pakistan

Email: drsadaf84@hotmail.com