

ASPECTS and Functional Outcomes in Left versus Right Hemisphere Strokes: A Prospective Cohort Study

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ABSTRACT

Background: Stroke presents as the second most prominent factor contributing to global mortality. Immediate brain imaging can be valuable for assessing functional recovery potential. This study investigated the association between Alberta Stroke Program Early CT Score (ASPECTS) and functional outcomes in patients with left and right-hemisphere strokes.

Methods: A prospective cohort study conducted in July-Dec2022, at a tertiary care hospital in Karachi including patients of either gender presenting within 2 days of stroke while excluding posterior circulation strokes, TIA & unwilling patients using a non-probability consecutive sampling technique. A total of 152 patients with acute ischemic stroke involving anterior circulation were analyzed and patients were categorized into two groups: the left hemisphere group (n=76) and the right hemisphere group (n=76) accordingly. ASPECTS scores were calculated from brain CT scans, while functional outcomes were measured using the modified Rankin Scale (mRS) at the three-month mark. Descriptive analysis and chi-square test were applied using SPSS vr25.

Results: Patients (n=152) had a mean age of 61.75 ± 13 years, with males comprising 67% of the cohort. ASPECTS scores were notably higher in left hemisphere strokes (median 9, IQR 2) than right hemisphere strokes (median 8, IQR 3) ($p=0.036$). Higher ASPECTS scores (≥ 7) correlated with improved outcomes (mRS ≤ 2) in both hemispheres. There was no statistically significant difference in both groups' functional outcomes ($p=0.182$).

Conclusion: ASPECTS predicts functional outcomes in acute ischemic strokes equally well regardless of the affected hemisphere.

Keywords: Middle Cerebral Artery Infarction, Ischemic Stroke, Recovery of Function.

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INTRODUCTION

Stroke represents a significant contributor to lasting disabilities and stands as the second most prominent factor contributing to global mortality¹. Ischemic strokes, caused by disruption of cerebral blood flow, account for the majority of stroke cases². The symptoms of a stroke can manifest rapidly, indicating a focal or widespread disturbance of cerebral function³. A significant differentiating factor between a stroke and a transient ischemic attack (TIA) is that stroke symptoms last longer than 24 hours, while TIA symptoms usually resolve within this timeframe. Moreover, a stroke often results in more severe and long-lasting neurological deficits than a TIA. While seizures, migraines, or psychosis can have stroke-like symptoms, they stem from different underlying causes and are present with unique distinguishing features. An exhaustive medical examination and diagnostic testing are essential to diagnose the cause of these symptoms accurately⁴. Early identification and management of ischemic changes are critical to improve outcomes, yet the 30-day mortality rate for ischemic strokes remains around 15%⁵. Early identification and management of ischemic changes are critical to improve patient outcomes. In Pakistan, the incidence of strokes varies by age and gender, with a peak rate of 584,000 per 650,000 cases in individuals aged 75-85 years old between 2000 and 2016⁶.

Imaging the brain shortly after a stroke is valuable for assessing functional recovery potential. Computed tomography (CT) scans currently represent the first-line imaging choice for acute stroke patients⁷⁻¹⁰. The Alberta Stroke Program Early CT Score (ASPECTS) is widely used to evaluate early ischemic changes in acute stroke cases, with scores above seven indicating a positive prognosis¹¹. ASPECTS has been employed in various stroke studies, guiding decisions on recanalization therapy and predicting patient outcomes regardless of the treatment method¹². The ASPECTS is a 10-point scoring system used in neurology to assess early ischemic changes on brain scans for stroke treatment. It involves specific regions of the Middle cerebral artery (MCA) territory and deducts points for observed abnormalities in these regions. An ASPECTS score of ≤ 7 is associated with a poor functional outcome at 3 months and an increased risk of symptomatic hemorrhage¹³. Though ASPECTS is associated with functional outcomes regardless of treatment, the prognostic value based on the hemisphere affected remains unclear¹⁴. Some studies suggest worse outcomes in right hemisphere strokes, but evidence conflicts.

This study described ASPECTS' ability to distinguish left/right hemisphere outcomes that may streamline prognosis and care. Comparing ASPECTS scores/outcomes between hemispheres may reveal insight for individualized rehabilitation/treatment

matching location/severity. Also, to determine if ASPECTS predicts outcomes differently by hemisphere to refine its prognostic role. This study investigated whether ASPECTS scores differ between left and right hemisphere strokes and whether these scores predict functional outcomes differently based on the hemisphere affected.

METHODS

This was a prospective cohort study conducted at the Department of Neurology in a tertiary care hospital in Karachi, Pakistan. The study received ethical approval from the Ethical Review Committee of Dr. Ziauddin University. (Reference Code: 5380522HANEU).

The target population was stroke patients aged 18 years and older. During the study, which lasted for six months (July 2022 - Dec 2022), ASPECTS scores were calculated at the time of patient presentation with stroke. Additionally, the modified Rankin Scale (mRS), which determined the functional outcome, was calculated during a follow-up at the three-month mark. The sample size was calculated WHO calculator with an absolute precision of 10%. The calculated sample size is 152 based on the good three-month outcome in the left and right hemispheres keeping a 95% confidence level dividing the groups by 76 patients in each group. A non-probability consecutive sampling technique was utilized.

The inclusion criteria comprised cases of either gender with anterior circulation stroke (as primary aspects were only designed for anterior circulation and a modified score is applied for posterior circulation), presenting to the hospital within 2 days of stroke onset, and not having a previous history of stroke, patients who died were also included in the study. Exclusion criteria included non-consenting patients, posterior circulation stroke cases, transient ischemic attack patients with no significant findings on imaging, and those undergoing mechanical thrombectomy (as this can influence outcomes) or lost to follow-up.

After obtaining informed consent, patient data was collected. This included history (including age, gender, and marital status), clinical examination, Glasgow Coma Scale (GCS) assessment, and non-contrast CT scan as part of the initial stroke workup. ASPECTS scores were calculated based on early ischemic CT scan changes by the principal investigator which were cross-checked by a certified neurologist. The National Institutes of Heart Stroke Scale (NIHSS) was excluded as it was not considered for this study. The modified Rankin Scale (mRS) score was assessed at 90 days follow-up in person to evaluate functional outcomes by the principal investigator under the supervision of a

certified neurologist. Patients were divided into left and right-hemisphere stroke groups based on involvement.

Statistical analysis was performed using SPSS version 25. Descriptive analyses used mean, standard deviation, percentages, and frequencies. Chi-square tests analyzed relationships, while logistic regression assessed associations. A p-value ≤ 0.05 indicated statistical significance.

RESULTS

In this study of 152 stroke patients, the mean age was 61.75±13 years, with the majority falling between 62-71 years. Male patients constituted 67% of the participants. The average weight was 69.1±11.7 kg, and the mean BMI was 26.9±6 kg/m².

The patients were equally divided into left and right-hemisphere stroke groups, with 76 patients in each. Left-sided strokes had higher ASPECTS scores compared to right-sided strokes, with a statistically significant difference (p=0.036). However, other baseline variables, including ICU and hospital stay duration and rehabilitation, showed no significant differences between the two groups. The overall mortality rate was 4.5%, with no significant difference between left and right hemisphere strokes. The ASPECTS score analysis reveals that 94 patients (61.8%) exhibited a significant enhancement in their functional outcomes, marking a notable improvement. Conversely, 58 patients (38.2%) experienced a less favorable trajectory, resulting in a decline in their functional well-being.

Table 1: Baseline demographics of stroke patients (n=152)

Variables	Right hemisphere (Mean±S.D)	Left hemisphere (Mean±S.D)
Age (years)	63.11±11	60.39±13
BMI (kg/m ²)	26.4±6	26.1±7.4
Weight (kg)	67.7±10	70.4±12
Height (cm)	1.5±0.15	1.5±0.12
Marital Status n (%)		
Married	75 (98.6%)	76 (100%)
Unmarried	1 (1.3%)	0 (0%)
GCS score at admission	13.7±2.3	13.4±2
ASPECT score	7.07±2.87	7.32±2.18
Mortality n (%)		
Yes	4 (5%)	3 (3.9%)
No	72 (94%)	73 (96%)
mRS	2.57±1.7	2.79±1

BMI: Body Mass Index , mRS: modified Rankin Scale , GCS: Glasgow Coma Scale

Table 1 summarizes the baseline demographics of stroke patients, with data separated by affected hemisphere. The results show that there are slight differences between the right hemisphere and left hemisphere stroke patients in terms of age, BMI,

weight, height, GCS score at admission, ASPECT score, mortality rates, and mRS scores. However, these differences are generally small and not necessarily clinically significant.

Table 2: Baseline Characteristics and Outcome of Left vs Right Hemisphere Strokes (n=76)

Variables	Left Hemisphere Median (IQR)	Right Hemisphere Median (IQR)	p-value
Age (years)	61 (20)	63.5 (13)	0.185
BMI (kg/m ²)	25.3 (5.2)	25.8 (6.8)	0.711

GCS at admission	15 (3)	15 (2)	0.259
ASPECTS score	9 (5)	8 (3)	0.038
Duration of ICU stay (days)	0 (2)	0 (1)	0.152
Duration of hospital stay (days)	3 (2)	2 (2)	0.446
Rehab (months)	0.75 (1)	0.75 (0.9)	0.734

BMI: Body Mass Index, mRS: modified Rankin Scale, GCS: Glasgow Coma Scale, p-value<0.05 is significant.

Table 2 compares baseline characteristics and outcomes between left and right hemisphere strokes in stroke patients (n=76). The table indicates that there are significant differences in ASPECTS score between left and right hemisphere strokes

(p=0.038), while other variables such as age, BMI, GCS at admission, duration of ICU stay, duration of hospital stay, and rehabilitation show no significant differences between the two groups.

Table 3: Classification of patient outcome according to the side of brain involvement (n=76)

Variables	Left Hemisphere n (%)	Right Hemisphere n (%)	p-value
ASPECTS			
≥ 7	23 (30%)	25 (32%)	0.727
< 7	53 (69%)	51 (67%)	
mRS			
(<2)	36 (47%)	34 (44%)	0.69
(2-6)	40 (53%)	43 (56%)	

mRS: modified Rankin Scale, A chi-square test was applied.

Table 3 compares patient outcomes based on left and right hemisphere involvement in 76 patients. It shows percentages for ASPECTS score (≥ 7 and < 7) and mRS score (< 2 and 2-6), with no significant

differences found between the two hemispheres (p > 0.05). This suggests similar outcomes regardless of the side of brain involvement.

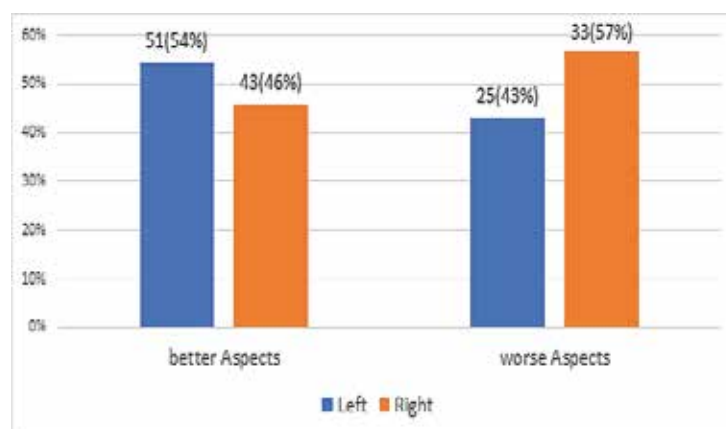


Figure 1: Outcome of ASPECTS score in Left & Right Hemisphere Strokes (Good ASPECTS: ≥ 7, Worse ASPECTS: <7)

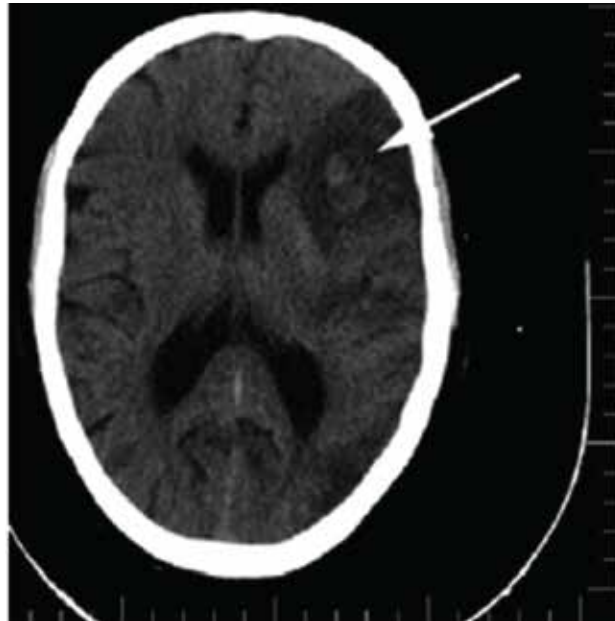


Figure 2: ASPECTS on this slice count to 6, however further slices are needed for complete quantification¹⁵.

DISCUSSION

ASPECTS is considered to be a robust clinical tool as it has exceptional reliability in the clinical setting. Pexman et al showed in their study that good to excellent reliability can be attained with ASPECTS when the symptom side of stroke is known¹⁶. While ASPECTS remains useful for predicting overall stroke prognosis, our findings suggest it may predict outcomes similarly for left and right hemisphere strokes. In our study, the results indicate that higher ASPECTS scores (≥ 7) are associated with better functional outcomes (mRS ≤ 2) in both left and right hemisphere strokes, which is consistent with other studies' findings¹⁶⁻¹⁸. However, the relationship between stroke laterality and outcomes appears complex, with evidence on this topic remaining mixed.

It has been suggested in some studies that right-hemisphere strokes may lead to worse functional outcomes or greater impairments in domains like mood and spatial skills compared to left-hemisphere strokes, our study did not find a significant difference in overall outcomes between the hemispheres^{19,20}. Also, the difference in functional outcomes was not statistically significant ($p=0.182$) in left vs right hemisphere strokes. A larger proportion of left-hemisphere stroke patients achieved a good outcome (mRS ≤ 2) compared to right-hemisphere patients (67% vs 56%), but this difference was not large enough in this study to be statistically significant. Other variables like age, gender, and hospital stay duration did not differ significantly between the two groups. GCS scores varied between left and right hemisphere strokes, with the lowest GCS scores associated with poorer outcomes in both groups.

Several factors may have contributed to this. First, laterality effects likely depend on the specific region or lobe affected rather than just the broad categorization of left vs right hemispheres. For example, right frontal lobe strokes may impact function differently than right parietal or occipital strokes. Second, individual patient characteristics like age, comorbidities, and stroke severity influence prognosis and were not fully accounted for in our study.

Other factors, such as the size and location of the infarct, the presence of other comorbidities, and the individual characteristics of the patients, may also influence functional outcomes and should be considered in clinical practice. Additionally, the prognostic value of ASPECTS in predicting functional outcomes highlights its utility as a bedside tool for guiding clinical decision-making and optimizing resource allocation in stroke care settings. This study has valuable insights, but there are limitations to consider. The small sample size of 152 patients may not represent the broader population, and the study was conducted at a single center, limiting its generalizability. The exclusion of patients with posterior circulation strokes, as this study was based on the primarily developed ASPECTS that focus only on the anterior circulation, and limited diversity among participants may affect the applicability of the results. However, a pc-ASPECTS has been developed and used in various studies to predict functional outcomes²¹⁻²⁶.

Furthermore, the study focused on limited variables and lacked long-term follow-up, hindering a comprehensive understanding of stroke outcomes and

differences between left and right-sided strokes, patients' handedness was not explored, hence dominance of the hemispheres was not studied. Factors like lifestyle habits, comorbidities, and treatments were not examined, potentially influencing the overall conclusions.

CONCLUSION

ASPECTS remains valuable for prognosis, but more research is needed to clarify hemisphere impact on prediction power. Larger samples, detailed neuroimaging, and long-term follow-up may reveal nuances in laterality. Prognosis seems more driven by ASPECTS score severity than hemisphere alone. Future work expanding on these limitations could enhance understanding to guide stroke management decisions.

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CONFLICT OF INTEREST

There is no conflict of interest between the authors.

ETHICAL APPROVAL

The study was initiated only after obtaining ethical approval from the Ethical Review Committee of Dr. Ziauddin University. (Reference Code: 5380522HANEU).

PATIENT CONSENT

Patients or their next of kin who agreed to participate in the study provided written informed consent in both English and Urdu languages.

AUTHORS CONTRIBUTION

HA conceived the idea, conducted the relevant literature search, and obtained permission from the Ethical Review Committee of Dr. Ziauddin University. HA also took the lead in writing the manuscript. BS, and IAK contributed to the literature search and played crucial roles in finalizing the discussion of the article. Additionally, they provided invaluable clinical support to the patients involved in the study. The collaborative efforts of all authors have significantly contributed to the completion and success of this research.

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