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Original Article

Cognitive Impairment in First-Ever Right Hemispheric Stroke: A Cross-Sectional Study

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ABSTRACT

Background: Cognitive dysfunction is a major, often under-recognized, determinant of long-term disability following stroke. While the right cerebral hemisphere is critical for non-verbal and integrative cognitive functions, dedicated studies evaluating the specific profile of cognitive impairment (CI) following first-ever right hemispheric stroke (RHS) in the Indian context are limited.
Objective: This cross-sectional study aimed to determine the prevalence and specific domains of cognitive impairment in patients with first-ever symptomatic RHS using a comprehensive neurocognitive assessment tool.
Methods: 64 patients with first ever symptomatic right hemispheric stroke were studied. Cognitive dysfunction was assessed with ACE-Malayalam and MMSE scores
Results: The prevalence of cognitive dysfunction in right hemispheric stroke was 95.3% by ACE scoring and 68.7% by MMSE scoring. The cognitive domains most affected were visuospatial, attention and verbal fluency. The least affected was language.
Conclusion: Cognitive impairment is an almost universal consequence of first-ever RHS. The significant disparity between M-ACE and MMSE detection rates underscores the critical need to employ comprehensive, multi-domain cognitive tools like the ACE for routine screening. The distinct pattern of non-linguistic deficits, primarily in visuospatial function and attention/executive domains, has profound implications for targeted cognitive rehabilitation and long-term functional recovery planning for stroke survivors.

Keywords*: Cognitive impairment, ACE-Malayalam, MMSE, Visuospatial dysfunction, Attention deficits, Verbal fluency.*

INTRODUCTION

Stroke remains a leading cause of mortality and the primary driver of severe neurological disability worldwide [1, 2]. While the immediate focus of acute stroke care is on mitigating motor and sensory deficits, the long-term burden is increasingly linked to non-motor sequelae, particularly **cognitive dysfunction** [3, 5]. In fact, post-stroke cognitive impairment (PSCI) is recognized as a key determinant of long-term outcome, often outweighing motor recovery in its impact on functional independence and quality of life [5, 6].

The rise in stroke incidence is a major public health concern in India, driven by an epidemiological transition towards lifestyle-related non-communicable diseases such as hypertension, diabetes, and dyslipidaemia [1, 4].[3] Within this context, understanding the specific impact of stroke location on cognitive outcome is paramount.

While both cerebral hemispheres contribute to the intricate web of cognition, the right hemisphere plays a specialized, dominant role in non-verbal, integrative processing [5, 7]. This includes crucial functions such as visuospatial judgement, sustained attention, affective communication, and social cognition [7, 8]. Consequently, patients with right hemispheric stroke (RHS) frequently present with a distinctive neuropsychological profile, encompassing hemispatial neglect, constructional apraxia, anosognosia (lack of awareness of deficits), and impaired executive and visuospatial functions [5, 8]. These deficits, particularly visuospatial and executive impairments, are strongly associated with poorer rehabilitation success, reduced capacity for activities of daily living (ADL), and increased long-term dependence [6, 8].

A significant clinical challenge in managing RHS is the inadequacy of brief screening tools. The Mini-Mental State Examination (MMSE), which primarily assesses language and memory, often fails to detect the characteristic non-linguistic deficits seen in RHS [8]. This gap necessitates the adoption of more comprehensive instruments, such as the Addenbrooke's Cognitive Examination (ACE), which delves into domains critical to right hemisphere function, including fluency, visuospatial ability, and attention [6, 8].

Despite the clear clinical relevance of RHS and the necessity for accurate cognitive profiling, data on this topic within the Indian population—particularly in high-risk, aging demographics like that of Kerala—are scarce. To address this knowledge gap, the current study was designed to rigorously evaluate the prevalence and specific patterns of cognitive impairment in patients experiencing their first-ever symptomatic right hemispheric stroke using standardized neurocognitive assessments.

METHODS

Study Design and Setting

This was a hospital-based, descriptive cross-sectional study conducted at the Department of Internal Medicine, Government Medical College, Thiruvananthapuram, India [9, 10]. Data were collected over a period of one year commencing in March 2013, following approval from the institutional ethics committee [10].

Participants and Sample Size

A total of 64 patients were included. The sample size was using the formula:

$$N = \frac{(Za)^2 P(100-P)}{D^2}$$

Za-1.96, if alpha error is =0.05
D-20% of P, if beta error -20%
P-Prevalence of cognitive dysfunction in patients with RHD [10]

Inclusion Criteria: Patients were included if they met all the following criteria: age <65 years, first-ever symptomatic RHS, ability to follow a three-step command, CT/MRI confirmation of a right hemispheric lesion, and provision of written informed consent (personally or via nearest kin) [9].

Exclusion Criteria: Exclusion criteria aimed to eliminate confounding factors: age >65 years, impaired consciousness, prior stroke history, pre-existing dementia or neuropsychiatric disorders, systemic illnesses affecting cognition (e.g., hepatic encephalopathy, severe renal or thyroid disease), psychoactive substance abuse, and other neurological disorders including left or bi-hemispheric stroke [10].

Data Collection and Tools

Clinical, demographic, and risk factor data were collected. Lesion diagnosis and localization were confirmed from the patient's clinical record using available CT or MRI reports [10].

1. **Mini-Mental State Examination (MMSE):** A brief, 30-point screening tool assessing orientation, registration, attention/calculation, recall, language, and visuoconstruction.[5] Cognitive dysfunction was defined as an MMSE score of <23 [11].
2. **Addenbrooke's Cognitive Examination – Malayalam (M-ACE):** A comprehensive assessment tool evaluating five domains: attention/orientation, memory, fluency, language, and visuospatial abilities. Cognitive impairment was defined by a M-ACE score of <88 [12].

Statistical Analysis

Data were analyzed using statistical software [10]. Descriptive statistics included frequencies and percentages for qualitative variables (e.g., risk factors, stroke subtype) and mean, median, standard deviation (SD), minimum, maximum, and quartiles for quantitative variables (e.g., age, cognitive domain scores) [10].

RESULTS

1. Demographic Characteristics

The majority of patients belonged to the 51–64-year age group (70.3%). There was a clear male predominance, with males constituting 65.6% of the sample. Over half of the cohort had only primary schooling (53.1%), suggesting lower-to-moderate literacy levels, which is a relevant factor for the interpretation of cognitive scores (Tables 1).

Table 1: Demographic Characteristics

Demographic Characteristics (N=64)	Frequency	Percent
Age in years		
<40	7	10.9
41-50	12	18.8
51-64	45	70.3
SEX		
Male	42	65.6
Female	22	34.4
Education		
No. of formal education	2	3.1
Primary	34	53.1
Secondary	26	40.6
Higher secondary or above	2	3.1

2. Vascular Risk Profile

The Study exhibited a high burden of cardiovascular risk factors. Hypertension (45.3%), diabetes mellitus (35.9%), and dyslipidaemia (23.4%) were the most common. Among male patients, high-risk lifestyle factors were prominent, with 83.3% reporting a history of smoking and 76.2% a history of alcohol consumption (Table 2).

Risk Factor (N=64)	Frequency	Percent
Hypertension		
Present	29	45.3
Absent	35	54.7
Diabetes mellitus		
Present	23	35.0
Absent	41	64.1
Dyslipidemia		
Present	15	23.4
Absent	49	76.6
Coronary artery disease		
Present	5	7.8
Absent	59	92.2
Atrial fibrillation		
Present	1	1.6
Absent	63	98.4

3. Percentage distribution of stroke patients based on drug history:

Among the total 64 patients studied, 34.4% were on anti hypertensives, 23.4% were on anti diabetics, 17.2% were on statins, 7.8% were on aspirin, 1.6% were on warfarin & another 1.6% were on other medications. However, 42.2% were not on any medications.

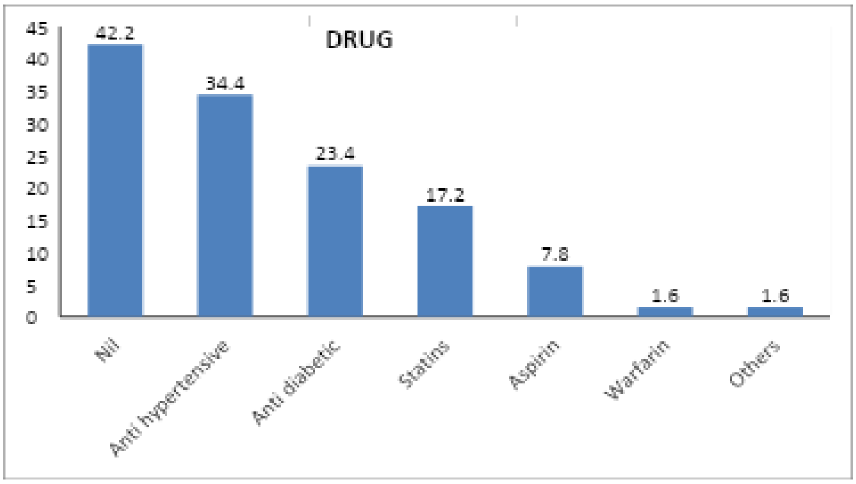

Fig 1: Percentage distribution of stroke patients based on drug history

4. Stroke Subtype and Lesion Distribution

The vast majority of strokes were ischemic (82.8%), with hemorrhagic strokes accounting for 14.1% of cases (Table 3). Anatomical analysis revealed that the most frequent sites of lesion involvement were the **basal ganglia plus internal capsule** (42%), followed by isolated basal ganglia lesions (16%), and fronto-parietal regions (13%) (Table 4).

SITE OF LESION	Frequency	Percent
Basal ganglia	10	16
Basal ganglia + internal capsule	27	42
Internal capsule	7	11
Corona radiate	2	3
Fronto parietal	8	13
Fronto temporal	1	2
Parietal	4	6
Parieto temporal	3	5
Parieto occipital	4	6

Percentage distribution of stroke patients based on type of lesion

TYPE	Frequency	Percent
Infarct	53	82.8
Infarct + Hemorrhage	2	3.1
Hemorrhage	9	14.1
Total	64	100.0

5. Median & mean values of the cognitive domains studied:

A box-and-whisker plot was used to illustrate the distribution of scores across the cognitive domains. In this plot, the lower and upper ends of the whiskers represent the minimum and maximum scores, respectively. The lower boundary of the green box corresponds to the first quartile (Q1), while the upper boundary of the purple box indicates the third quartile (Q3). The horizontal line within each box denotes the median score.

The median scores for the domains were as follows: Orientation (70.0), Attention (50.0), Memory (68.6), Fluency (57.1), Language (75.0), and Visuospatial ability (30.0). Among these, the Visuospatial domain demonstrated the lowest median score, whereas the Language domain exhibited the highest.

Table 5: Median & mean values of the cognitive domains studied.

	N	Mean	S.D.	Minimum	Q1	Medium	Q3	Maximum
ORIENT	64	7.31	1.807	2	6.00	7.00	9.00	10
TIME	64	3.27	1.172	0	2.00	3.00	4.00	5
PLACE	64	4.05	983	2	3.00	4.00	5.00	5
ATTEN	64	4.67	2.101	0	3.00	4.00	7.00	8
3OBJ	64	2.73.	654	0	3.00	3.00	3.00	3
S.SUB	64	1.91	1.841	0	.00	1.00	4.00	5
MEM	64	23.28	5.013	14	19.25	24.00	27.00	33
RECALL	64	2.19	.814	0	2.00	2.00	3.00	3
ANT	64	15.44	3.523	0	10.00	16.00	18.00	21
DEL. REC	64	2.94	2.115	0	1.00	3.00	4.00	7
RETRO	64	2.66	1.027	0	2.00	3.00	3.75	4
FLUEN	64	7.91	2.804	0	6.00	8.00	9.00	14
LETTER	64	3.83	1.420	0	3.00	4.00	4.00	7
CAT	64	4.08	1.525	0	3.00	4.00	5.00	7
LANG	64	20.02	4.933	9	17.00	21.00	23.75	28
NAM	64	8.17	2.628	1	7.00	8.00	10.00	12
COMP	64	6.66	1.359	3	6.00	7.00	8.00	8
REP	64	3.98	1.386	0	4.00	4.00	5.00	5
READ	64	.73	.859	0	.00	.00	2.00	2
WRITE	64	.45	.502	0	.00	.00	1.00	1
VIS SL	64	2.05	1.608	0	1.00	1.50	3.00	5
SHAPE	64	.64	.784	0	.00	.00	1.00	2
CLOCK	64	1.41	1.050	0	1.00	1.00	2.75	3
ACE	64	65.19	13.737	33	56.25	65.00	74.75	93
MMSE	64	20.81	5.045	10	17.25	21.00	25.00	30

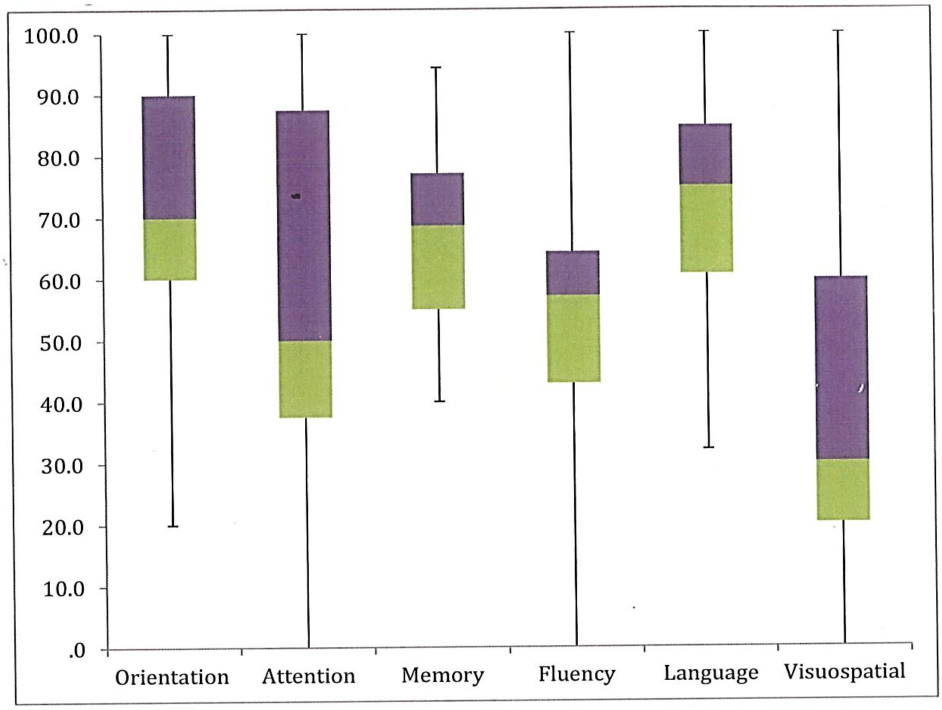

Fig: Box and whisker plot for the cognitive domains examined

6. Cognitive dysfunction as per Addenbrooke's scoring:
As per Addenbrooke's scoring system, 95.3% of the subjects studied had cognitive dysfunction.

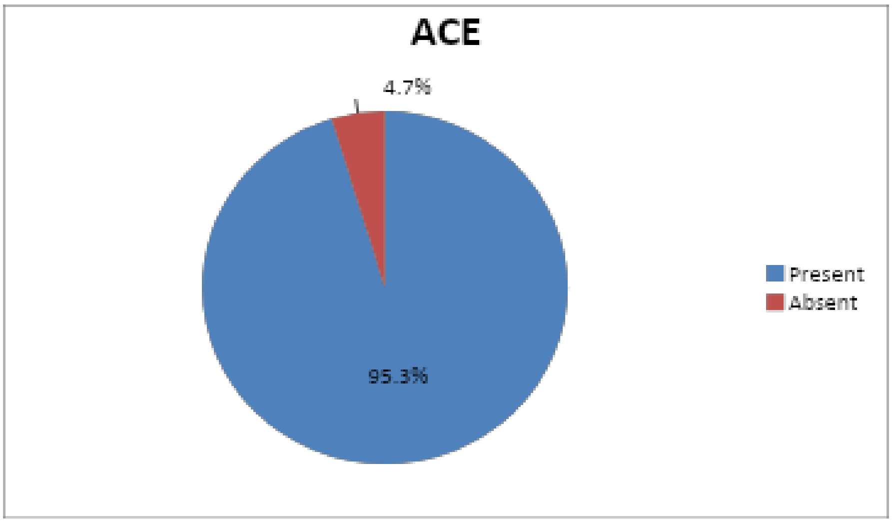

Fig : Percentage distribution of sample based on cognitive dysfunction as per Addenbrooke's scoring.

DISCUSSION

The findings of this study powerfully underscore that cognitive impairment is an alarmingly common, almost universal, consequence of first-ever right hemispheric stroke, affecting 95.3% of our cohort when evaluated comprehensively with the ACE. This prevalence far exceeds the 68.7% detected by the MMSE, supporting prior research that highlights the critical limitations of relying on brief, language-centric tools like the MMSE to screen for the non-verbal deficits characteristic of RHS [8, 16].

The demographic profile of our subjects predominantly in the 51-64 year age bracket and bearing a high prevalence of vascular risk factors (hypertension, diabetes)—is consistent with the clinical and epidemiological context of stroke in rapidly developing societies [1, 16]. The lower-to-moderate educational status of the cohort further reinforces the necessity of using a nuanced assessment like the ACE, which is comparatively less influenced by formal education than the MMSE, ensuring a more accurate measurement of core cognitive deficits [17].

The anatomical findings revealed that lesions involving the **basal ganglia and internal capsule** were the most common (42%). These subcortical structures and their interconnecting white matter tracts form key components of the frontal-subcortical circuits, which are integral for executive functioning, attention, and cognitive speed [18]. This anatomical predilection provides a compelling biological explanation for the significant observed deficits in **attention** and **fluency** [18].

The most salient finding of the study, however, is the profound and specific impairment in **visuospatial ability** (median score 30.0%). This domain, encompassing spatial judgment, constructional skills, and perceptual integration, is a hallmark function of the right hemisphere [19]. The relative preservation of **language** (median score 75.0%) further emphasizes the qualitative difference between left and right hemisphere stroke, confirming that the impact of RHS is largely in the non-linguistic, integrative domains [7]. The presence of severe visuospatial and executive deficits is not merely an academic point; it directly translates to poorer outcomes, as these impairments severely limit an individual's capacity for ADL, ambulation, and social engagement [19].

In summary, this research provides strong evidence from an Indian tertiary care setting that post-stroke cognitive evaluation must move beyond the MMSE standard for patients with RHS. The use of a robust, multi-domain tool such as the ACE is essential for the timely and accurate identification of these prevalent and debilitating non-linguistic impairments. Recognizing this distinct cognitive profile is the first crucial step toward designing targeted cognitive rehabilitation programs, thus improving functional outcomes and reducing the long-term dependency of stroke survivors [17].

CONCLUSION

Cognitive impairment is demonstrated to be an overwhelming and distinct consequence of first-ever right hemispheric stroke, affecting the vast majority of patients. The Addenbrooke's Cognitive Examination (ACE) was shown to be vastly superior to the Mini-Mental State Examination (MMSE) in detecting these deficits. The observed pattern of severe deficits in **visuospatial ability**, attention, and verbal fluency, with relative preservation of core language, reinforces the specialized role of the right hemisphere in non-linguistic cognitive integration. These findings mandate the routine incorporation of comprehensive cognitive assessment, such as the ACE, into standard post-stroke care protocols to ensure that all patients receive appropriate, targeted cognitive rehabilitation for their specific profile of non-linguistic dysfunction.

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