Clinical Profile and Cognitive Outcomes in Young Stroke Patients: A Prospective Observational Study

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KEYWORDS

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ABSTRACT

Introduction: Stroke in young adults represents a critical and emerging health challenge, with increasing incidence. This prospective observational study aimed to comprehensively analyze the clinical characteristics, risk factors, and cognitive outcomes of stroke patients aged 18-45 years. We investigated the etiology, clinical profile, and cognitive outcomes of stroke in young adults.

Methodology: A prospective observational study was conducted at Department of Neurology Kasturba Medical College-Manipal from November 2023 to August 2024, involving 34 patients aged 18-45 years with confirmed ischemic stroke. Comprehensive diagnostic workups included blood investigations, neuroimaging, and cardiovascular assessments. Outcomes were evaluated using the National Institutes of Health Stroke Scale (NIHSS), Montreal Cognitive Assessment (MoCA), and Modified Rankin Scale (mRS) at baseline and 3-month follow-up.

Results: The majority of participants (63.8%) were between 36-45 years, with a near-balanced gender distribution (52.8% female). Dyslipidemia (82.4%) being the most common risk factor. Significant improvements were observed across neurological and cognitive assessments. NIHSS scores improved from 4.56 to 2.56 (p=0.0001), MoCA scores increased from 22.09 to 25.38 (p=0.0001), and mRS scores decreased from 1.82 to 1.09 (p=0.001). Strong correlations were found between neurological deficits, cognitive function, and functional outcomes.

Conclusion: The study highlights the complex nature of stroke in young adults, emphasizing the importance of early intervention, comprehensive assessment, and multidimensional rehabilitation strategies. Modifiable risk factors such as dyslipidemia, hypertension, and smoking emerge as critical targets for prevention.

INTRODUCTION:

Non-communicable diseases like stroke is significant in this present era. Stroke in young is in increasing trend in this present era. Despite advancements in medical technology and understanding of cerebrovascular diseases, stroke in young adults (18-45 years) represents a critical area of concern that demands comprehensive investigation.

The clinical profile of stroke in young patients differs substantially from older patients, characterized by distinct etiological factors, risk profiles, and potential long-term consequences. While older populations typically experience stroke due to age-related comorbidities such as

atherosclerosis and cardiovascular diseases, younger patients often present with more diverse and complex underlying mechanisms. These may include genetic predispositions, autoimmune disorders, specific cardiovascular conditions, and lifestyle-related risk factors that are increasingly prevalent in younger demographics.[1,2]

Cognitive outcomes following stroke represent a critical dimension of patient recovery and long-term quality of life. Young stroke survivors face unique challenges in cognitive rehabilitation, with potential impacts on educational pursuits, professional development, and social functioning. Neuroplasticity and cognitive reserve in younger patients offer promising avenues for recovery, yet the specific trajectories and mechanisms of cognitive restoration remain incompletely understood.[3,4]

Existing literature highlights significant variations in stroke etiology, clinical manifestations, and cognitive sequelae among young adults. Epidemiological studies have documented an alarming increase in stroke incidence in this age group, with estimates suggesting that 10-15% of all stroke events now occur in individuals under 45 years of age.[5] This trend underscores the critical need for targeted research that can elucidate the specific clinical characteristics and cognitive implications of stroke in younger populations.

The multifaceted nature of stroke in young adults necessitates a comprehensive approach to assessment and management. Factors such as underlying etiopathogenesis, specific stroke subtypes, acute management strategies, and long-term rehabilitation protocols require detailed investigation. Moreover, the potential for substantial life-course disruption makes understanding the clinical and cognitive dimensions of stroke in young patients particularly imperative.[6,7]

This study aims to provide a comprehensive analysis of the clinical profile and cognitive outcomes in young stroke patients, addressing critical gaps in current knowledge. By examining a cohort of patients aged 18-45 years, the research is done to study the etiology of stroke in young adults and to study the clinical and cognitive outcome in stroke in young.

The significance of this research extends beyond clinical understanding, potentially informing early intervention strategies, rehabilitation protocols, and preventive approaches for young stroke survivors. Understanding the unique challenges faced by this demographic can lead to more personalized and effective medical and neuropsychological interventions (8,9,10).[8,9,10]

METHODOLOGY:

This prospective observational study was conducted at the Department of Neurology, Kasturba Medical College-Manipal, from November 1st, 2023, to August 31st, 2024. The research focused on a cohort of 34 patients aged 18-45 years with confirmed ischemic stroke diagnosed according to WHO criteria.

Patient selection followed strict inclusion and exclusion protocols. Participants were carefully screened, excluding those with head trauma, neuroinfections causing stroke, venous strokes, CNS tumors, pregnancy, or epidural/subdural hematomas. A comprehensive clinical evaluation was performed for each patient, documenting detailed demographic information, educational status, and medical history. This included assessing addictions (smoking, alcohol, tobacco), pre-existing conditions like hypertension, diabetes, and dyslipidemia, and prior cardiovascular risk factors.

A comprehensive diagnostic workup was implemented. Blood investigations encompassed complete blood count, inflammatory markers (ESR and CRP), diabetes profile, kidney and liver function tests, and lipid profile. An extensive autoimmune screening was conducted, including ANA profile, antiphospholipid antibodies, rheumatoid factor, homocysteine levels, and complete coagulation studies.

Neuroimaging played a crucial role in the study. Patients underwent CT or MRI brain scans to identify acute stroke evidence. Angiography was performed using CT or MRI to detect large

vessel occlusion, aneurysms, or intracranial atherosclerotic disease. Selected cases received additional diagnostic procedures like digital subtraction angiography (DSA) or vessel wall imaging to investigate potential CNS vasculitis. Cardiovascular assessments included ECG, echocardiography (ECHO), transesophageal echocardiography (TEE), and web cardio to evaluate cardiac complications.

Three standardized assessment tools were employed to evaluate patient outcomes. The National Institutes of Health Stroke Scale (NIHSS) objectively quantified stroke impairment, categorizing patients into minor (0-4), moderate (5-15), or severe (16-20) stroke impact groups. The Modified Rankin Scale (mRS) assessed functional outcomes, classifying results as favorable (0-2) or unfavorable (3-5). The Montreal Cognitive Assessment (MoCA) evaluated cognitive function, with scores categorized as severe (0-9), moderate (10-17), mild (18-25), or normal (26 and above).

Assessments were conducted at baseline and during follow-up (3 months), providing a comprehensive view of patient progression. Statistical analysis utilized descriptive statistics, with categorical variables analyzed using Chi-square tests, continuous variables examined through Pearson correlation, and paired t-tests employed to compare baseline and follow-up scores.

The study received approval from the Kasturba Medical College and Hospital Institutional Ethics Committee and was registered with the Clinical Trial Registry of India, ensuring adherence to rigorous ethical standards in medical research.

RESULTS:

Table 1: Demographic and clinical characteristics of study participants

AGE GROUPS (IN YEARS)	**Frequency (n = 34)**
18 – 35:36 – 45	13(38%):21(62%)
GENDER	
Male: Female	16(47%):18(53%)
ADDICTIONS	

Smoking and Tobacco chewing/Ethanol	12(33%)/3(9%)
Dyslipidemia	28(78%)
Hypertension	12(33%)
Type 2 Diabetes Mellitus	9(27%)
Prior CVA or TIA	2(5%)
AF/Heart blocks/Congenital heart diseases	5(14%)

The age distribution shows that the majority of participants (62%) were between 36-45 years old, followed by 38% in the 36-40 years age group. The gender distribution is almost balanced, with 53% females and 47% males. The addiction history reveals that 47% of participants had some form of addiction, with smoking being the most prevalent at 33.3%, followed by ethanol use.
The major risk factors were predominantly dyslipidemia (82.4%), followed by hypertension (35.3%) and type 2 diabetes (26.5%).

Table 2: Toast/arterial territory and etiological profile

Ischemic territory	**Frequency (n = 34)**
MCA Territory	12 (35%)
Posterior Circulation	10 (30%)
ACA territory	1(2%)
Multiple	11(33%)

Hemisphere	**Frequency (n = 34)**
Right	10(30%)
Left	10(30%)
Bilateral	6(16%)
Brainstem and cerebellum	8(24%)
TOAST	Frequency (n = 34)
Cardioembolic	8(24%)
Large vessel occlusion	8(24%)
Other determined	4(11%)
Small vessel occlusion	10(30%)
Undetermined	4(11%)
ETIOLOGICAL PROFILE	FREQUENCY (N = 34)
Autoimmune	6(18%)

Hematological	7(20%)
CNS vasculitis	4(11%)
Cardiac (PFO/ARRYTHMIA/CHD)	8(24%)
Atherosclerosis	9(27%)

In terms of vascular territory, the middle cerebral artery (MCA) territory was most commonly affected (35.3%), followed closely by multiple territories (33%) and posterior circulation (30%). The hemisphere involvement was relatively evenly distributed, with 30% for both right and left cerebral hemispheres, 16% bilateral, and 24% involving the brainstem and cerebellum.

Table 3: Outcome Assessments at Baseline and 3 Months

Assessment	Category	Baseline (%)	3 months follow up (%)
NIHSS	Minor (0-4)	18 (52.9%)	27 (79.4%)
	Moderate (5-15)	14 (41.2%)	6 (17.6%)
	Severe (16-20)	2 (5.9%)	1 (2.9%)
MOCA	Normal (>26)	13 (38.2%)	22 (64.7%)
	Mild (18-25)	12 (35.3%)	10 (29.4%)
	Moderate (10-17)	8 (23.5%)	2 (5.9%)
	Severe (0-9)	1 (2.9%)	0
Modified Rankin Scale	Favourable (0-2)	25 (73.5%)	28 (82.4%)
	Unfavourable (3-5)	9 (26.5%)	6 (17.6%)

For the National Institutes of Health Stroke Scale (NIHSS), there was a significant improvement: at baseline, 52.9% had minor strokes, which increased to 79.4% at 3 months. Severe strokes decreased from 5.9% to 2.9%. The Montreal Cognitive Assessment (MoCA) also showed improvement, with the proportion of participants with normal cognitive function increasing from 38.2% to 64.7%. The Modified Rankin Scale (mRS) demonstrated a positive trend, with favorable outcomes increasing from 73.5% to 82.4%. (Table 3)

Table 4: Mean comparison at baseline and 3 months

Variable	Baseline (Mean ± SD)	3 months (Mean ± SD)	P value
NIHSS	4.56 ± 4.93	2.56 ± 3.86	0.0001
MOCA	22.09 ± 6.54	25.38 ± 4.31	0.0001
mRS	1.82 ± 1.24	1.09 ± 1.08	0.001

The NIHSS mean score decreased from 4.56 to 2.56, indicating improved neurological function (p=0.0001). The MoCA score improved from 22.09 to 25.38, suggesting cognitive enhancement

(p=0.0001). The Modified Rankin Scale mean score reduced from 1.82 to 1.09, reflecting better functional outcomes (p=0.001). All these changes were statistically significant. (Table 4)

Table 5: Correlation between different variables

Variables	**Correlation Coefficient (r)**	P value
NIHSS baseline vs MOCA baseline	-0.536	0.0001
NIHSS baseline vs mRS baseline	-0.429	0.009
MOCA at 3 months vs Age	-0.196	0.268
MOCA at 3 months vs NIHSS at 3 months	-0.404	0.018
NIHSS at 3 months vs mRS at 3 months	0.602	<0.001
MOCA at 3 months vs mRS at 3 months	-0.559	0.001

There were several notable correlations: a moderate negative correlation between baseline NIHSS and MOCA scores (r=-0.536, p=0.0001), suggesting that higher stroke severity is associated with lower cognitive function. The NIHSS at 3 months showed a strong positive correlation with mRS at 3 months (r=0.602, p<0.001), indicating that increased neurological deficits are associated with poorer functional outcomes. The MoCA at 3 months had a moderate negative correlation with mRS at 3 months (r=-0.559, p=0.001), implying that improved cognitive function is linked to better functional recovery. (Table 5)

DISCUSSION:

The study focused on stroke among young individuals aged 18-45 years, revealing a significant health concern with increasing hospitalization rates. The age distribution showed majority of participants (62%) were between 36-45 years old.[11-13] The gender distribution was nearly balanced, with a slight female predominance, which differs from some previous studies that showed male preponderance.[14-16]. This variation in study finding in relation to gender distribution in Udupi district may be due to different rate of admission as the female & male ratio(1093:1000) according to Udupi census as per Udupi District - Population from 2011-2024.

Risk factors analysis highlighted dyslipidemia as the most prevalent, followed by hypertension and diabetes.[17] Smoking was the most common addiction, with conventional risk factors similar to those seen in older populations.[11,14,15] The study showed that anterior circulation being the most frequently involved vascular territory. Large artery atherosclerosis and cardio embolism were the most common stroke classifications for anterior circulation, while posterior circulation showed more varied etiologies.[15,17,18]

Functional and cognitive outcomes were assessed using NIHSS, MoCA, and modified Rankin Scale (mRS) at baseline and 3-month follow-up. The study demonstrated significant improvements in neurological status, functional recovery, and cognitive function over time.[17,19-22] Cognitive impairment was initially prevalent, but most patients showed good recovery by the 3-month follow-up. We emphasized the importance of early and repeated cognitive assessments, suggesting that comprehensive evaluation should include emotional, behavioral, and psychological factors, particularly for more complex rehabilitation goals.

The study acknowledges several key limitations that impact the interpretation and generalizability of its findings. As a single-center study with a small sample size of only 34 patients, the research may not fully represent the broader population of young stroke patients. The

limited follow-up period of just 3 months restricts the ability to assess long-term cognitive and functional outcomes comprehensively. Additionally, the study's inclusion of diverse stroke etiologies resulted in small subgroup sizes, which complicates meaningful comparisons and statistical analyses. These methodological constraints suggest that while the findings provide valuable insights, they should be interpreted with caution and viewed as preliminary evidence necessitating further investigation through larger, multi-center studies with extended follow-up periods to validate and expand upon the current observations.

CONCLUSION:

This study highlights that diverse etiologies and risk factors are involved in young stroke. Dyslipidemia, hypertension, and smoking emerged as major modifiable risk factors, suggesting a need for targeted prevention strategies. Small vessel occlusion as the most common TOAST classification. Functional and cognitive outcomes demonstrated significant improvement over the 3-month follow-up period, supported by effective early interventions. However, the correlations between NIHSS, mRS, and MOCA emphasize the need for a multidimensional approach to stroke management. The findings reiterate the importance of early cognitive assessment using tools like MOCA and functional outcome tools like mRS are useful to identify deficits and guide rehabilitation strategies. The strength of this study is it provides valuable insights into the unique challenges of managing young stroke patients.

Conflict of Interest

The authors declare that this is an original article with no conflicts of interest.

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