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DEPRESSION IN POST-ISCHEMIC STROKE PATIENTS: CORRELATION WITH BRAIN INVOLVEMENT USING FUNCTIONAL MRI

Neurology

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ABSTRACT

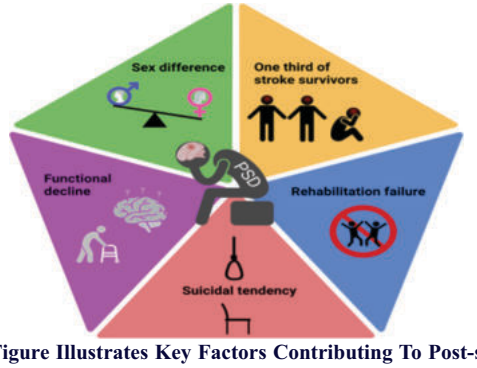
Background: Stroke is a major global health concern, ranking as a leading cause of mortality and long-term disability. Post-stroke depression (PSD) affects over 40% of patients and complicates recovery. While psychological stressors contribute, neurobiological factors such as brain injury location are crucial. **Aims & Objectives:** This study aims to analyze the correlation between brain lesion locations and the incidence of depression in post-ischemic stroke patients using functional MRI, focusing on the Indian population to enhance understanding and treatment of PSD. **Methods:** An observational case-control study was conducted at CSS Hospital, Meerut, from September 2022 to August 2024, involving 50 participants (25 ischemic stroke patients with depression and 25 age- and gender-matched controls). Patients were followed up for 3 months and reassessed. Ethical approval was obtained, and informed consent was secured from all participants. The severity of depression was assessed using the Montgomery-Åsberg Depression Rating Scale (MADRS), and functional MRI findings were analyzed. **Results:** The study found that bilateral capsuloganglionic lacunar infarcts and right MCA territory infarcts were the most common brain lesions associated with PSD. The mean MADRS scores increased significantly from 15.76 at admission to 26.00 after three months, indicating worsening depressive symptoms. **Conclusions:** The findings highlight the significant prevalence of PSD and its correlation with specific brain lesions in ischemic stroke patients. This underscores the need for routine screening and targeted interventions to improve rehabilitation outcomes.

KEYWORDS

Post-stroke depression; ischemic stroke; functional MRI; brain lesions; MADRS.

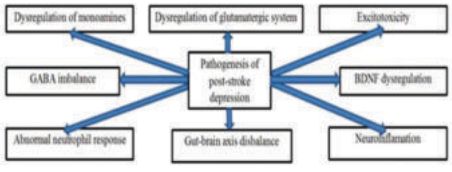
INTRODUCTION

Stroke stands as a major public health concern globally, ranking as the second leading cause of mortality and a significant contributor to long-term disability.[1] The World Health Organization defines stroke as the sudden onset of clinical symptoms indicative of cerebral dysfunction due to vascular causes, lasting more than 24 hours or leading to death.[2] Among the two primary types of stroke, ischemic stroke, which accounts for approximately 80% of all cases, occurs when blood flow to the brain is blocked, often by a clot or atherosclerotic plaque.[3] The damage caused by ischemia often results in functional impairment, with the ischemic core being the region where brain cells suffer irreversible death. Surrounding this core is the ischemic penumbra, a zone of potentially salvageable cells that becomes the focus of therapeutic intervention.[4]



This Figure Illustrates Key Factors Contributing To Post-stroke Depression In Survivors

One of the most debilitating complications in stroke survivors is post-stroke depression (PSD), a condition that affects over 40% of patients in the early months following a stroke. PSD significantly hampers recovery and reduces quality of life.[5] While psychological stress due to disability and loss of independence are key contributing factors, growing evidence suggests that neurobiological elements, such as the location and extent of brain injury, also play a crucial role in the onset of PSD.[6] Despite its prevalence, the mechanisms underlying PSD remain poorly understood, complicating the treatment and prognosis of stroke patients.



This Figure Illustrates Neurobiological Pathways Involved In The Pathogenesis Of Post-stroke Depression

Advances in neuroimaging, particularly functional MRI, offer new insights into the correlation between specific brain regions affected by ischemic stroke and the development of depression.[7,8] However, existing research presents conflicting findings, with some studies associating PSD with left frontal lesions, while others point to involvement of the right hemisphere and subcortical areas. This lack of consensus highlights the need for further investigation. Our study aims to address this gap, focusing on the Indian population, by analyzing the correlation between brain lesion location and PSD through functional MRI. Understanding this relationship will not only enhance the identification of patients at risk but also pave the way for targeted interventions that can significantly improve post-stroke rehabilitation outcomes.

MATERIALS AND METHODS

Study Design: This observational case-control study aimed to assess the occurrence of depression in post-ischemic stroke patients and correlate it with specific brain regions using functional MRI.

Study Population: Patients diagnosed with ischemic stroke from the Medicine and Neurology departments at CSS Hospital, Subharti Medical College, Meerut, were recruited. Age- and gender-matched patients diagnosed with depressive disorders served as controls. Both groups included male and female patients.

Study Setting and Period: The study was conducted at CSS Hospital from September 2022 to August 2024.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethical Committee, and informed consent was acquired

from all participants or their legal guardians after explaining the study's purpose.

Sample Size: The study enrolled 50 participants: 25 ischemic stroke patients with depression and 25 controls matched by age and gender.

Inclusion and Exclusion Criteria

Patients aged 18-80 years with MRI-confirmed ischemic stroke were included. Controls were matched for age and gender. Exclusion criteria for cases included hemorrhagic strokes, recurrent strokes, or a recent history of depression. Controls with past strokes or substance dependence were excluded.

Study Variables

The main variables assessed were psychiatric diagnosis (ICD-10) and depression severity using the MADRS score. Functional MRI findings were analyzed to identify brain regions associated with depression.

Methodology

All patients underwent detailed medical and neurological examinations, and ischemic stroke was confirmed via MRI. Functional MRI was performed at admission and one month later. Depression was assessed at one and three months using the MADRS score, with comparisons made between stroke patients and controls to explore brain-depression correlations.

Data Analysis

Data were analyzed using SYSTAT13.2. Continuous variables were assessed using Student's t-test, while categorical data were evaluated using the Chi-square or Fischer's exact test, with $p \leq 0.05$ deemed statistically significant.

RESULTS

Table 1 Demographic Characteristics of Study Subjects

DEMOGRAPHIC CHARACTERISTICS	Frequency	Percentage (%)
AGE GROUP (years)		
30-40	3	12.00
41-50	8	32.00
51-60	5	20.00
61-70	6	24.00
71-80	3	12.00
Total	25	100.00
Mean Age	54.84 ± 12.80	
GENDER		
Male	14	56.00
Female	11	44.00
Total	25	100.00

This table presents the age and gender distribution of the study subjects. The majority of participants (32%) fall in the 41-50 years age group, and 56% of the subjects are male, while 44% are female. The mean age of the study population is 54.84 ± 12.80 years.

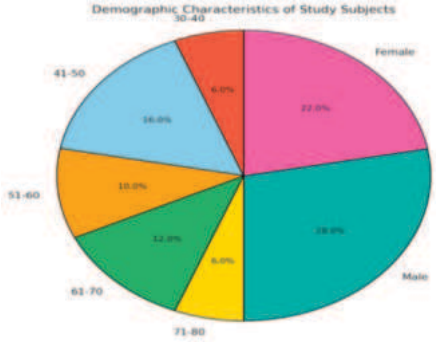
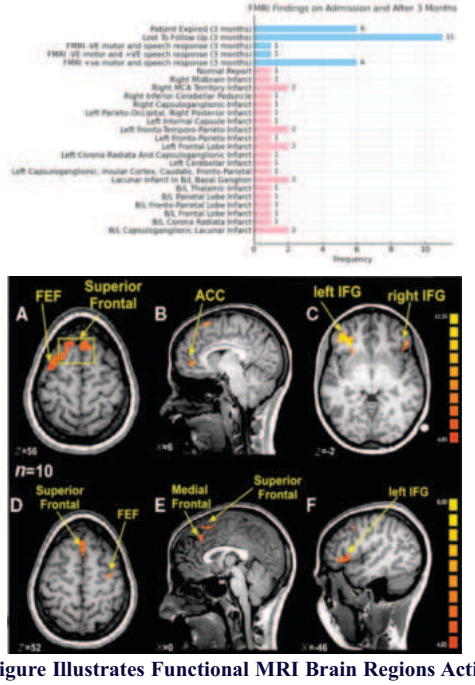


Table 2 FMRI Findings on Admission and After 3 Months of Study Subjects

FMRI Findings	Frequency	%
ON ADMISSION		
B/L Capsuloganglionic Lacunar Infarct	2	8.00
B/L Corona Radiata Infarct	1	4.00
B/L Frontal Lobe Infarct	1	4.00
B/L Fronto-Parietal Lobe Infarct	1	4.00
B/L Parietal Lobe Infarct	1	4.00
B/L Thalamic Infarct	1	4.00
Lacunar Infarct In B/L Basal Ganglion	2	8.00
Left Capsuloganglionic, Insular Cortex, Caudate, Fronto-Parietal	1	4.00
Left Cerebellar Infarct	1	4.00
Left Corona Radiata And Capsuloganglionic Infarct	1	4.00
Left Frontal Lobe Infarct	2	8.00
Left Fronto-Parieto Infarct	1	4.00
Left Fronto-Temporo-Parieto Infarct	2	8.00
Left Internal Capsule Infarct	1	4.00
Left Parieto-Occipital, Right Posterior Infarct	1	4.00
Right Capsuloganglionic Infarct	1	4.00
Right Inferior Cerebellar Peduncle	1	4.00
Right MCA Territory Infarct	2	8.00
Right Midbrain Infarct	1	4.00
Normal Report	1	4.00
AFTER 3 MONTHS		
FMRI showing +ve motor and speech response	6	24.00
FMRI showing -VE motor and +VE speech response	1	4.00
FMRI showing -VE motor and speech response	1	4.00
Lost To Follow Up	11	44.00
Patient Expired	6	24.00
Total	25	100.00

This table presents the FMRI findings of study subjects both at the time of admission and after 3 months. A variety of infarcts were observed, with B/L Capsuloganglionic Lacunar Infarct and Right MCA Territory Infarct each being the most frequent at admission (8%), while 24% of subjects showed positive motor and speech responses after 3 months, and 44% were lost to follow-up.



This Figure Illustrates Functional MRI Brain Regions Activated in Post-Stroke Depression

Table 3 Distribution of Study Subjects by Side of Involvement and Cortical Involvement

Side of Involvement	Frequency	Percentage
Right	5	20.83
Left	9	37.50
Bilateral	10	41.67
Total (Side of Involvement)	24	100.00
Cortical Involvement		
Cortical	11	45.83
Subcortical	12	50.00
Both Cortical and Subcortical	1	4.17
Total (Cortical Involvement)	24	100.00

This table presents the distribution of study subjects based on the side of involvement and the type of cortical involvement. The majority of subjects exhibited bilateral involvement (41.67%), while subcortical involvement was noted in 50.00% of the cases, indicating a significant prevalence of subcortical pathology.

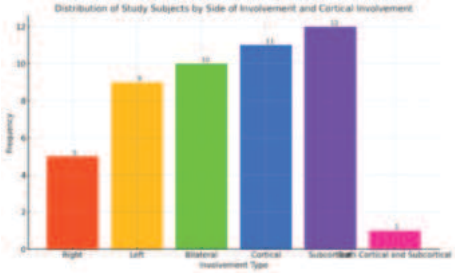
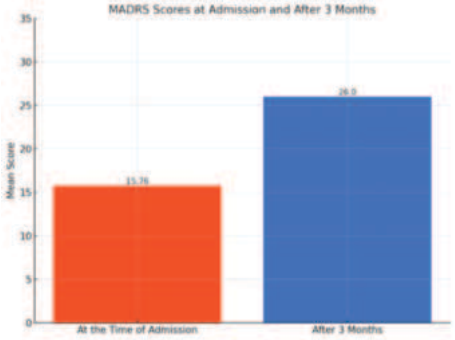


Table 4 MADRS Scores at Admission and After 3 Months

MADRS Score	Mean	Standard Deviation (SD)	t Value	P Value
At the Time of Admission	15.76	4.48	4.011	0.000*
After 3 Months	26.00	10.30		

This table summarizes the Mean MADRS scores at the time of admission and after three months of treatment. A significant increase in the MADRS score from 15.76 at admission to 26.00 after three months indicates a marked improvement in the subjects' depressive symptoms.



DISCUSSION

In our study, the demographic characteristics of the study subjects, indicating a total of 25 participants. The age distribution shows that the majority (32%) fall within the 41-50 years age group, with a mean age of 54.84 years (±12.80). Gender distribution reveals that 56% of the subjects are male, while 44% are female, indicating a slight male predominance. Similar findings were observed in a study conducted by Amaricai E et al.[9], which reported that age-related factors did not significantly influence depression scores in post-stroke patients, reinforcing the relevance of age demographics in understanding PSD.

In our study, we observed fMRI findings for study subjects at the time of admission and after three months. A variety of infarcts were noted, with bilateral capsuloganglionic lacunar infarct and right MCA territory infarct being the most common, each occurring in 8% of the participants. After three months, 24% of the subjects exhibited positive motor and speech responses, while a substantial 44% were lost to follow-up. These findings resonate with Vataja R et al.[10]'s study, which indicated that depression was prevalent in 40% of patients, often associated with infarcts in prefrontosubcortical circuits. Their logistic regression analysis highlighted left-sided infarcts as significant correlates of PSD, mirroring the findings of this study regarding the relationship between specific brain lesions and depressive symptoms.

Our study also highlights the distribution of study subjects based on the side and type of cortical involvement. It indicates that 41.67% of the subjects exhibited bilateral involvement, with a notable prevalence of subcortical involvement (50.00%). This finding underscores the complexity of stroke-related depression, where bilateral and subcortical pathology plays a crucial role. Previous studies, including the work by Vataja R et al.[10], have shown similar trends, indicating that left-sided infarcts in the genu of the internal capsule and other subcortical regions are significantly correlated with depressive symptoms, further validating the importance of understanding the distribution of stroke lesions in relation to mood disorders.

The MADRS scores also presented in our study that demonstrate a significant increase from an average score of 15.76 at the time of admission to 26.00 after three months, reflecting a notable worsening of depressive symptoms among the subjects. This substantial increase in scores indicates the importance of ongoing monitoring and treatment of depressive symptoms in post-stroke patients. In a comparable study by Amaricai E et al.[9], it was reported that 52.6% of post-stroke patients experienced moderate to extreme depression, emphasizing the strong association between depressive symptoms and functional ability in this population. The findings from Singh A et al.[11] also support this, suggesting that functional impairment is a key predictor of depression post-stroke, highlighting the need for a comprehensive approach to address both physical and psychological rehabilitation in stroke survivors. In conclusion, our study provide a comprehensive overview of the demographic characteristics, fMRI findings, side of involvement, and MADRS scores in post-stroke patients, underscoring the significant correlation between brain pathology and the prevalence of post-stroke depression. The findings are consistent with existing literature, which emphasizes the necessity for targeted interventions in this population to enhance overall recovery and quality of life.

Recommendations

In terms of recommendations, it is crucial to implement routine screening for depression in post-stroke patients, utilizing tools like functional MRI to guide targeted interventions. Furthermore, multidisciplinary approaches involving neurologists, psychiatrists, and rehabilitation specialists should be adopted to address both physical and psychological aspects of recovery.

Limitations

The study's limitations include a relatively small sample size and the short follow-up duration, which may limit the generalizability of the findings. Future research should involve larger cohorts and longer-term follow-up to further elucidate the relationship between brain lesions and PSD.

CONCLUSION

The study highlights the significant prevalence of post-stroke depression (PSD) among ischemic stroke patients, with notable correlations between specific brain lesions and depressive symptoms. The demographic analysis indicated that most participants were in the 41-50 age group, with a slight male predominance. The functional MRI findings revealed various infarcts, with bilateral capsuloganglionic lacunar infarcts and right MCA territory infarcts being the most common. Additionally, the MADRS scores showed a marked increase from admission to three months post-stroke, indicating worsening depressive symptoms. These results underscore the necessity of monitoring and addressing depressive symptoms in stroke rehabilitation, emphasizing the importance of identifying patients at risk for PSD through neuroimaging and other assessments. By integrating psychological support into stroke recovery programs, healthcare providers can significantly improve patients' quality of life and functional outcomes.

Conflict of Interest: The authors declare no conflicts of interest.
Funding: No funding was received.
Consent: Written consent from participants has been obtained and preserved.
Ethical Approval: Ethical approval was obtained and documented as per institutional guidelines.

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