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Case Study

Impact of Lesion Locations on the Severity of Post-Stroke Depression

Yusak MT Siahaan [1,2,*], Fernando Dharmaraja [1], Evlyne E Suryawijaya [1,2]

[1] Department of Neurology, Faculty of Medicine, Pelita Harapan University, Tangerang, Indonesia
[2] Department of Neurology, Siloam Hospital Lippo Village, Tangerang, Indonesia

* Correspondence: Yusak MT Siahaan (yusak.siahaan@lecturer.uph.edu)

Abstract: Background: Depression occurs in one-third of stroke patients, in what is known as post-stroke depression. The lesion sites in stroke have been associated with the degree of depression. However, studies have provided different perspectives, and this necessitates further clarification. This study investigates the relationship between the lesion sites and the severity of depression in ischemic stroke patients. **Methods:** This cross-sectional study was conducted between January and April 2020. All samples were obtained from admitted patients with ischemic stroke who agreed to participate in the study. Data were collected using Beck's Depression Inventory-II (BDI-II), which was used to determine the severity of depression, and the lesion sites were based on radiological imaging interpretation. **Results**: The study showed a significant association between the lesion site and the degree of depression (OR = 5,368, p-value = 0,013). Lesions in the frontal lobe demonstrated stronger associations with the severity of depression. **Conclusion:** The location of the lesion, especially in the frontal lobe, was associated with more severe post-stroke depression.

Keywords: Ischemic Stroke, Post-Stroke Depression, Site of Lesion

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1. Introduction

Stroke is the second most common cause of death globally. The prevalence of stroke in Indonesia increased abruptly from 7% in 2013 to 10.9% in 2018, according to Basic Health Research (RISKESDAS). Furthermore, stroke and ischemic heart diseases resulted in approximately 15,2 million deaths (15-15,6 million) in 2015.[1]

Post-stroke depression (PSD) is common in stroke patients, occurring in approximately 30–50%.[2, 3] PSD refers to persistent depression after stroke with symptoms such as loss of interest, decreased energy, decreased appetite, sleep disturbances, low self-esteem, self-blame, repeated attempts of self-injury, and suicidal thoughts.[4] Psychiatrists have also recognized PSD for 100 years, as new control studies started in 1970. Stroke patients with depression have a higher risk of suboptimal healing, recurrence of vascular events, decreased quality of life, and mortality.[5] The relationship between changes in neuroanatomical factors as the cause of depression is still a hypothesis, as several other factors contribute to depression. Several studies have shown that infarction of certain brain lobes, such as the frontal and temporal lobes, is significantly associated with depression. Those studies are also supported by the frontal subcortical circuit (FSC) and limbic-cortical-striatal-pallidal-thalamic circuit (LCSPTC) theory which mentions that a variety of neuropsychiatric disorders may result from disturbances that have a direct or indirect impact on the integrity or functioning of frontal-subcortical circuits.[6-8] However, another study by Srivastava *et al*. found no association between site lesions and depression.[5, 9] Based on the above studies, there are different opinions and findings on the

relationship between stroke lesion location and the severity of post-stroke depression. Although many studies have been carried out about the role of frontal lobes on depression in stroke cases, we emphasize that the other lobes of the brain also trigger depression. Therefore, the author wished to investigate further the association between lesion location and the severity of depression in patients with ischemic stroke.

2. Methods

This cross-sectional study was conducted at the neurological department of the Siloam Hospital Lippo Village General Hospital. A purposive non-probability sampling technique was used. The participants were ischemic stroke patients with a history of infarction for not less than three months. Inclusion criteria were also a Glasgow coma scale of 15, a minimum age of 18 years with a stable mental and physical state during the interview and were willing to participate. Patients with a history of depression were excluded from the study. The study was conducted for four months between January and April 2020. The locations of lesions and severity of depression were obtained using computed tomography scans and Beck Depression Index-II (BDI-II), respectively. A validated questionnaire in the Indonesian language was also used to collect the demographic data. The data collected were statistically analyzed using the *chi-squared* test in SPSS version 25.0. In addition, *P*-values less than 0.05 were considered statistically significant.

3. Results

A total of 62 patients with ischemic stroke from the neurology department of the Siloam Hospital Lippo Village General Hospital participated in this study. The participants were provided with questionnaires containing 21 questions. The author verified that the responses were consistent with the conditions the participants felt after an ischemic stroke.

- Table 1 shows that 36 and 26 of the 62 ischemic stroke patients who responded were males and females, respectively, with an average age of 56.77 ± 8.407 years. Their levels of education were categorized as low (fewer than 12) and high (equal to or higher than 12). More than half of the participants (56.5%) had lower educational levels. Most stroke lesions were located in the frontal and temporal lobes (43.5% and 37.1%, respectively); only a few were located in the parietal and occipital lobes (14.5% and 4.9 %, respectively). According to the severity of depression assessments based on the BDI-II questionnaire responses, the patients were classified into minimal, mild, moderate, and severe groups. None of the patients had severe depression; most had mild or moderate depression (56.4 vs. 35.5%). Only five patients had moderate depression.
- Table 2 shows 27 patients with ischemic stroke in the frontal lobe experienced mild to moderate depression (63%). Meanwhile, patients with stroke lesions in the temporal lobe mainly experienced minimal depression (65%). Most patients with lesions in both parietal and occipital lobes had minimal depression; only one had moderate depression.
- Table 3 shows a significant association between lesions in the frontal lobe and the severity of depression. However, the relationship was not statistically significant for other variables such as temporal lobe localization, age, gender, and educational level.

Table 1. Participant demographic data, stroke lesion location (lobes), and level of depression.

Respondent Data (n=62)		Frequency (n)	Percentage (%)
Age	< 60 years old	32	51,6
	≥ 60 years old	30	48,4
Gender	Male	36	58,1
	Female	26	41,9
Education	Low Education	35	56,5
	High Education	27	43,5
Lesion Location	Frontal lobe	27	43,5
	Temporal lobe	23	37,1
	Parietal lobe	9	14,5
	Occipital lobe	3	4,9
Level of Depression	Minimal	35	56,4
	Mild	22	35,5
	Moderate	5	8,1
	Severe	0	0

Table 2. Location of stroke lesion and the severity of depression

Location of Stroke Lesion	Level of Depression			Total
	Minimal (%)	Mild (%)	Moderate (%)	
Frontal Lobe	10	15	2	27
Temporal Lobe	15	7	1	23
Parietal Lobe	8	0	1	9
Occipital Lobe	2	0	1	3
Total	35	22	5	62

Table 3. Bivariate analysis of stroke location and demographic data and the severity of depression

Variables	Percentage (%)	Odds Ratios			P-value
		Mild vs. Minimal	Moderate vs. Mild	Mild vs. Moderate	
Frontal Lobe	56.5	5.358	1.667	0.311	0.013
Temporal Lobe	37.1	0.622	0.333	0.535	0.486
Age (> 60 Years old)	51.6	0.75	0.188	0.25	0.275
Gender (Female)	41.9	1.083	1.125	1.038	0.985
Education Level (Low education)	56.5	0.556	2.667	0.208	0.289

3. Discussion

The data analysis showed a significant relationship between the location of a stroke lesion and the severity of depression (p-value = 0.013, OR = 5.358). The results also showed the probability of an 84.27% higher occurrence of depression in patients with ischemic

stroke in the frontal lobe. These results indicate that mild-to-moderate depression is more likely to occur in stroke patients with lesions in the frontal lobe than in any other lobe. PSD occurs due to the ischemic conditions of the brain that highly affect the functioning of neurons and the system that compromises the production of neurotransmitters associated with depression, such as serotonin.[5,10] In addition, the inflammatory process that results from the destruction of brain cells secretes inflammatory factors that deactivate the phosphorylation of the nuclear factor inhibitor kappa B (IκB). In consequence, NF-κB increases the transcription of associated genes and promotes gene expression, creating conditions that increase susceptibility to depression. [2, 4] Another factor related to the anatomical changes of the brain in depression is the location of the lesion. The frontal and temporal lobes contain frontal subcortical circuits (FSC) and limbic-cortical-striatal-pallidal-thalamic circuits (LCSPTC), which directly influence emotional regulation.[11]

The results of this study show a higher incidence of post-stroke depression (ranging from 16.3% to 23%) in patients with frontal lobe lesions, which is consistent with reports by Shi *et al.*, Metoki *et al.*, Hama *et al.*, and Wang *et al.* [7, 8, 12] The patients were classified according to the severity of depression associated with different lesions. This differs from the approach of previous studies that only differentiated the forms of depression. The study showed that most patients with frontal lobe stroke lesions have an increased risk of mild to moderate depression than those with lesions outside the frontal lobe.[13]

In this study, other variables, such as age, previously known to be associated with severe depression, were analyzed. In this study, other variables, such as age, previously known to be associated with severe depression, were analyzed. Age could increase or decrease the severity of depression, also affects physical and psychological factors that increase susceptibility to depression.[14] In this study, the correlation between age and depression tended to be clinically significant, given the protective nature of the research participants' age being less than 60 years. This indicates that younger adults are less likely to experience depression than older adults. However, the correlation between age and the severity of depression tends not to be statistically significant, as its prevalence differs with different populations.[15] This is attributable to the different cultural backgrounds in Indonesia, restrictions on physical activities, and disabilities of older adults. Gender is also considered a factor that affects depression severity, as studies have consistently shown that women are more susceptible to depression. [16, 17] This is consistent with a study showing that females have a higher prevalence of neurotic traits than males, which triggers high levels of depression among women. Furthermore, a study involving 403 students aged 13–16 showed increased depressive symptoms and suicidal thoughts in female students. [18] However, in this study, gender was concluded to have no significant clinical or analytical relationship with depression. Educational level was another variable to consider. According to a study conducted by Bauldry *et al.*, a high level of education reduces the risk of depression. Participants with a high level of education demonstrated protective effects against neurotic events, which are common predictors of depression. [19, 20] In this study, a high educational level showed a protective effect against mild depression. At the same time, the risk of major depression was higher with a higher level of education; however, this was not statistically significant, and more data are needed. The differences in educational systems in Indonesia seemed to have affected the results; neurotic events tend to occur more frequently in patients with low academic levels.

Some of the limitations of this study include its small sample size and the unequal distribution of stroke lesions; most patients presented with frontal lobe ischemic stroke. One of the main strengths of this study was the analysis of other factors; depression has several confounding factors that tend to affect the results of studies.

4. Conclusion

Post-stroke depression is a common complication in ischemic stroke patients. There is a significant relationship between lesion location and the severity of depression in patients with ischemic stroke. The frontal lobe has a higher odd ratio for mild and moderate depression than other brain lession, which must be treated before progressing to a more severe form or worsening recovery time.

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