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Risk Factors for Stroke in Lacunar Ischemic Stroke Patients

Thalita Permata Padhantya Irwanda,[1] Muhammad Ihwan Narwanto,[2] Komang Yunita Wiryaning Putri[3]
[1]Faculty of Medicine, University of Jember, Jember, Indonesia
[2]Department of Anatomy, Faculty of Medicine, University of Jember, Jember, Indonesia
[3]Department of Neurology, Faculty of Medicine, University of Jember, Jember, Indonesia

Abstract

The shift in global epidemiology has significantly increased the prevalence of non-communicable diseases, positioning stroke as one of the primary contributors to both disability and vascular-related mortality worldwide, with a notable impact observed in Asia. This research endeavours to explore the correlation between various stroke risk factors and the occurrence of lacunar stroke at Dr Soebandi Regional Hospital, Jember, Indonesia. Employing a cross-sectional correlational design, the study drew upon data extracted from medical records of 41 patients who had experienced a first-time ischemic stroke between 2022 and 2023. The primary variables under investigation were gender, age, hypertension, diabetes mellitus, dyslipidaemia, and heart disease. Statistical analysis conducted with Chi-square test indicated a significant association between hypertension and diabetes mellitus, with both conditions linked to an 11-fold increased risk of lacunar stroke compared to having only one condition. In contrast, factors such as age, gender, dyslipidaemia, and heart disease did not exhibit significant associations. These results emphasize the imperative for rigorous management of hypertension and diabetes to reduce the risk of lacunar stroke.

Keywords: Diabetes mellitus, hypertension, ischemic stroke, lacunar stroke, stroke risk factors

Introduction

The epidemiological transition has significantly increased the burden of non-communicable diseases, with stroke emerging as a leading cause of disability and vascular death worldwide, including in Asia. According to the World Health Organization, stroke is defined as the rapid onset of clinical signs of focal or global disturbance of cerebral function lasting 24 hours or more, with no apparent cause other than vascular origin.[1] The Global Burden of Disease (GBD) 2019 report identifies stroke as the second leading cause of death and the third leading cause of mortality and disability globally, accounting for 12.2 million new cases, 101 million people living with stroke-induced disability, and 6.5 million stroke-related deaths in that year.[2] In Indonesia, the 2018 Basic Health Research (RISKESDAS) reported an overall stroke prevalence of 10.9 per 1,000 population, with Jember Regency at 12.4 per 1,000. This marks an increase from the 2013 RISKESDAS, which recorded a prevalence of 7.9 per 1,000 in Jember, highlighting a rising trend in stroke cases within the region.[4]

Stroke is categorized into hemorrhagic and ischemic types. Ischemic strokes constitute about 80% of all stroke cases, with hemorrhagic strokes making up the remaining 20%.[5] The Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification further divides ischemic strokes into five subtypes: extensive artery atherosclerosis, cardioembolism, small vessel occlusion (lacunar), a stroke of other determined aetiology, and stroke of undetermined aetiology.[6]

Lacunar stroke, a subtype of ischemic stroke, is caused by the occlusion of small penetrating branches of cerebral blood vessels in the circle of Willis.[7] Representing 20–30% of all ischemic strokes, lacunar strokes are the most common subtype according to the Harvard Stroke Registry.[8] The risk factors for lacunar stroke include modifiable factors such as hypertension, diabetes mellitus, high cholesterol, cardiovascular diseases, and lifestyle choices, as well as non-modifiable factors like age and gender.[5,9] Despite extensive research

Corresponding Author:
Muhammad Ihwan Narwanto
Department of Anatomy, Faculty of Medicine, University of Jember, Jember, Indonesia
Email: muhammadnarwanto@unej.ac.id

on ischemic stroke, data specifically on lacunar stroke remain limited, particularly in Indonesia. Local variations in demographic and clinical characteristics may influence risk factor patterns, making hospital-based evidence essential for targeted prevention strategies. To date, no study has specifically analyzed lacunar ischemic stroke risk factors at Dr. Soebandi Regional Hospital, Jember. Therefore, this study aims to identify the association between common stroke risk factors (age, sex, hypertension, diabetes mellitus, dyslipidemia, and heart disease) and the incidence of lacunar stroke, as well as determine which factors show the strongest relationship in this population.

Methods

The study employed a correlational analytic method with a cross-sectional design to investigate the risk factors associated with lacunar stroke among patients at Dr Soebandi Regional Hospital in Jember. Data collection was conducted from May to July 2024 through the hospital's Medical Records Department. The study population consisted of all patients diagnosed with first-time ischemic stroke between 2022 and 2023. A purposive sampling technique was used to select participants, with inclusion criteria such as patients aged 18 years or older, diagnosed with first-time ischemic stroke, and possessing complete medical records that included information on age, gender, ischemic stroke subtype, blood pressure, and LDL lipid profile results. Exclusion criteria included patients with a history of brain malignancies, recurrent stroke, meningitis, or epilepsy.

The minimum required sample size was calculated using a correlational analytic formula, resulting in 32 participants. Data for the study were obtained from secondary sources, specifically medical records, which were organized into a data collection sheet to ensure consistency in capturing relevant variables related to stroke risk factors and ischemic stroke subtypes. Ethical approval was granted by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Jember (No. 1133/UN5.1.10.2/KE/2024).

Data were retrospectively collected from patient's medical records and recorded using a standardized data collection sheet. The primary outcome variable was the incidence of lacunar stroke, identified through neuroimaging reports interpreted by radiology specialists at Dr Soebandi Regional Hospital. Lacunar stroke was defined as an ischemic stroke of the lacunar subtype in patients experiencing their first stroke event.

The primary outcome variable was lacunar stroke, identified from neuroimaging reports interpreted by radiology specialists at Dr. Soebandi Regional Hospital. Lacunar stroke was defined as an ischemic stroke of the lacunar subtype in patients experiencing their first stroke event. Independent variables included gender (male or female), age (<55 years vs. ≥55 years), hypertension, diabetes mellitus, dyslipidemia, and heart disease. Hypertension was defined as a systolic blood pressure exceeding 140 mmHg and/or a diastolic blood pressure exceeding 90 mmHg at the time of stroke diagnosis. Patients were classified as hypertensive if they met these criteria or, as usual, if they did not, measured on a nominal scale. Diabetes Mellitus was identified in patients who met at least two of the following criteria: fasting plasma glucose level ≥126 mg/dL, random plasma glucose level ≥200 mg/dL, plasma glucose level ≥200 mg/dL two hours after an oral glucose tolerance test, or glycated haemoglobin (HbA1c) level ≥6.5%. Based on these criteria, patients were categorized as diabetic or usual, again using a nominal scale. Dyslipidemia was determined by elevated LDL cholesterol levels of ≥100 mg/dL, with patients being classified as having dyslipidemia if they met this threshold or, as usual, if their LDL levels were below 100 mg/dL, also on a nominal scale. Lastly, heart disease includes patients diagnosed by cardiologists with conditions affecting the coronary vessels, pericardium, heart valves, or myocardium. Patients were classified as having heart disease (yes) or not having heart disease (no) based on their medical records, assessed on a nominal scale.

Data were presented in table and text formats, and statistical analysis was performed to interpret the associations between various risk factors and the incidence of lacunar stroke. Statistical analysis was performed using the Chi-square test to determine associations between risk factors and the incidence of lacunar stroke. A significance level of $p<0.05$ was applied.

Results

The collected data included patient age, gender, hypertension status, dyslipidemia, diabetes, heart disease, and ischemic stroke subtype. The study was conducted from May 16 to July 10, 2024, and 41 subjects met the inclusion and

exclusion criteria. The results are presented in Table 1.

Unmodifiable risk factors for lacunar stroke consist of gender and age. Based on data, lacunar stroke occurred more in males (61.9%) than females (38.1%). The age variable showed that in lacunar stroke, more subjects were affected by stroke at the age of ≥55 years (76.2%) than subjects affected by stroke at the age of <55 years (23.8%).

Modifiable risk factors for lacunar stroke consist of hypertension, diabetes, dyslipidemia, and heart disease. The hypertension variable showed that there were more subjects with hypertension (90.5%) compared to nonhypertension (9.5%). The diabetes variable showed that in lacunar stroke, more subjects had diabetes (67.7%) than those who did not have diabetes (33.3%). The dyslipidemia variable showed that more subjects had dyslipidemia (51.2%) than subjects who did not have dyslipidemia (42.9%). The heart disease variable showed that more subjects did not have heart disease (81%) than those who had heart disease (19%). Bivariate analysis demonstrated that hypertension and diabetes were significantly associated with lacunar stroke ($p<0.05$), with odds ratios indicating an increased likelihood of lacunar stroke in patients with these conditions. Dyslipidemia, heart disease, age, and gender were not statistically significant risk factors.

Discussion

This study investigated the relationship between multiple risk factors and the incidence of lacunar stroke among patients at Dr Soebandi Regional Hospital in Jember. Hypertension and diabetes mellitus demonstrated significant associations with lacunar stroke, whereas gender, age, dyslipidaemia, and heart disease did not show statistically significant relationships.

Male patients accounted for 61% of the study population and 61.9% of those with lacunar stroke. Although the proportion of males with

Table 1 Risk Factors Relationship with Lacunar Stroke

Risk Factor Characteristics	Lacunar (n=21)		Non-lacunar (n=20)		Total Sample (n=41)		p-value	Odds Ratio
	n	%	n	%	n	%		
Gender								
Male	13	61.9	12	60.0	25	61.0	0.901	
Female	8	38.1	8	40.0	16	39.0		
Age (years)								
<55	5	23.8	7	35.0	12	29.3	0.431	
≥55	16	76.2	13	65.0	29	70.7		
Hypertension								
Normal	2	9.5	9	45.0	11	26.8	0.010*	6.567
Hypertension	19	90.5	11	55.0	30	73.2		
Diabetes								
Normal	7	33.3	14	70.0	21	51.2	0.019*	5.512
Diabetes	14	66.7	6	30.0	20	48.8		
Dyslipidaemia								
Normal	9	42.9	9	45.0	18	43.9	0.890	
Dyslipidaemia	12	57.1	11	55.0	23	56.1		
Heart Disease								
Absent	17	81.0	13	65.0	30	73.2	0.249	
Present	4	19.0	7	35.0	11	26.8		
Hypertension and Diabetes								
Absent	8	38.1	18	90.0	26	63.4	0.001*	11.896
Present	13	61.9	2	10.0	15	36.6		

*p-value significant for α 0.05

lacunar stroke was higher than that of females, the association between gender and lacunar stroke was not statistically significant (p=0.901). This finding aligns with the study by Yu et al[10], which also reported no significant relationship between gender and lacunar stroke incidence. However, another study suggests that lifestyle factors prevalent among males, such as alcohol consumption and smoking, may contribute to a higher incidence of lacunar stroke in men.[11] Tobacco products contain harmful chemicals that can cause vascular endothelial damage, leading to thrombosis, atherosclerosis, and platelet aggregation.[12] Over time, these changes can result in arteriolosclerosis, reduced vessel diameter, and eventual occlusion, culminating in stroke.[13]

Most lacunar stroke cases occurred in patients aged ≥55 years (76.2%), aligning with previous evidence that lacunar stroke commonly affects individuals aged 55–75 years.[14] However, the association between age and lacunar stroke was not statistically significant in this study (p= 0.431). Younger patients (<55 years) tend to have risk factors such as heavy alcohol consumption, smoking, and obesity. In contrast, traditional vascular risk factors like hypertension and dyslipidemia are more common in older adults (≥55 years), contributing to an increased risk of lacunar stroke.[15] The ageing process after 50 years leads to decreased vascular elasticity and increased arterial stiffness, which heightens the risk of small vessel pathology like lacunar stroke.[16]

Hypertension showed a significant association with lacunar stroke (p=0.010), with an odds ratio (OR) of 6.567, indicating a markedly higher risk among hypertensive individuals. This result corroborates findings from Lioutas et al[17], who also reported a significant relationship between hypertension and lacunar stroke. Hypertension contributes to vascular damage due to increased pressure that overwhelms the autoregulatory capacity of small vessels. This leads to forced dilation, endothelial damage, and subsequent thickening and narrowing of the vessel walls.[8] The resulting arteriolar changes, such as lipo hyalinosis, are pathological hallmarks of lacunar stroke.[9] Endothelial dysfunction impairs autoregulation and can lead to vessel occlusion and lacunar infarction due to compromised perfusion and vessel wall thickening.[18]

Diabetes mellitus was also significantly associated with lacunar stroke (p=0.019), with an OR of 5.512, suggesting that diabetic patients have a sixfold increased risk of developing lacunar stroke compared to non-diabetic individuals. Similar conclusions were drawn from a study by Lioutas et al. [17], who reported that diabetes increases the risk of lacunar stroke fourfold. The bidirectional relationship between ischemic stroke and diabetes implies that each condition can predispose individuals to the other.[19] Severe ischemia during a stroke can induce post-stroke hyperglycemia due to neuroendocrine activation and stress hormone release, leading to increased gluconeogenesis, glycogenolysis, and lipolysis.[20] Diabetes contributes to microvascular damage through oxidative stress and excessive accumulation of advanced glycation end products, resulting in increased vascular permeability and protein deposition.[21]

Although 57.1% of lacunar stroke patients had dyslipidaemia, the association was not statistically significant (p=0.890). This finding is consistent with Harris et al.[22], who also reported no significant relationship between dyslipidemia and lacunar stroke despite a relatively high prevalence of dyslipidemia among stroke patients. Dyslipidemia, characterized by abnormal lipid and lipoprotein levels, is known to contribute to atherosclerosis and increase stroke risk.[5] In small vessel disease, atherosclerosis can manifest through mechanisms such as plaque extension from large arteries into small vessels or in situ microadenoma formation within small arteries.[23] Moreover, dyslipidemia is often associated with diabetes, which can exacerbate metabolic abnormalities and vascular complications.[19]

Heart disease did not show a significant association with lacunar stroke (p=0.249). Only 19% of patients with lacunar stroke had a history of heart disease, including conditions like heart failure, diastolic dysfunction, myocardial infarction, and coronary artery disease. According to Huber et al.,[24] certain heart diseases, such as atrial fibrillation and heart failure, can increase stroke risk by promoting thrombus formation, which may lead to arterial occlusion when emboli enter the systemic circulation. In heart failure, factors like stasis of circulation, hypercoagulability, and endothelial dysfunction contribute to thrombus formation and potential vessel occlusion.[25] However, the lack of significant findings in this study may be due to the low prevalence of specific cardiac conditions like atrial fibrillation among the participants.

The combination of hypertension and diabetes further increased the risk of lacunar

stroke, with an OR of 11.896.). This finding underscores the synergistic impact of these risk factors on lacunar stroke incidence. Teshome et al. [12] reported that hypertensive patients with diabetes mellitus have a 2.25 times higher risk of stroke compared to hypertensive patients without diabetes. Diabetes mellitus leads to chronic hyperglycemia, insulin resistance, and dyslipidemia.[20] In combination with hypertension, these factors promote insulin resistance, atherosclerotic plaque development, and vascular dysfunction.[19,20]

This study has limitations, including its cross-sectional design, which prevents causal inference. The sample size was relatively small, potentially limiting generalizability. Additionally, the study relied on secondary data from medical records, which may have inherent limitations such as incomplete documentation or variability in diagnostic criteria.

The significant associations between hypertension, diabetes, and lacunar stroke highlight the need for effective management of these modifiable risk factors. Healthcare providers should prioritize early detection and control of hypertension and diabetes to reduce the incidence of lacunar stroke. Public health initiatives focusing on lifestyle modifications, such as promoting healthy diets, regular physical activity, and smoking cessation, are essential in mitigating these risk factors. Further research with larger sample sizes, prospective designs and multi center are recommended to validate these findings and explore the mechanisms underlying the associations.

This study concludes that hypertension and diabetes mellitus are significantly associated with lacunar stroke incidence, with hypertension conferring a particularly high risk. The presence of both hypertension and diabetes simultaneously increases the risk of lacunar stroke compared to individuals with only one of these risk factors.

References

1. Chugh C. Acute ischemic stroke: management approach. Indian J Crit Care Med. 2019;23(Suppl 2):S140. doi:10.5005/jp-journals-10071-23192
2. Feigin VL, Brainin M, Norrving B, Martins S, Sacco RL, Hacke W, et al. World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. International J Stroke. 2022;17(1):18–29. doi:10.1177/17474930211065917
3. Venketasubramanian N, Yoon BW, Pandian J, Navarro JC. Stroke Epidemiology in South, East, and South-East Asia: a review. J Stroke. 2017;19(3):286–94. doi:10.5853/jos.2017.00234
4. Kementerian Kesehatan RI. Prevalensi stroke berdasarkan diagnosis dokter pada penduduk umur ≥15 tahun menurut Provinsi, 2018. Laporan Nasional Riskesdas 2018. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan; 2019.
5. Boehme AK, Esenwa C, Elkind MSV. Stroke risk factors, genetics, and prevention. Circ Res. 2017;120(3):472–95. doi:10.1161/CIRCRESAHA.116.308398
6. Murphy SJX, Werring DJ. Stroke: causes and clinical features. Medicine. 2020;48(9):561–6. doi:10.1016/j.mpmed.2020.06.002
7. Statpearls. Lacunar Stroke. [Internet] 2024 [cited 2024 July 22]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK563216.
8. Regenhardt RW, Das AS, Ohtomo R, Lo EH, Ayata C, Gurol ME. Pathophysiology of lacunar stroke: history's mysteries and modern interpretations. J Stroke Cerebrovasc Dis. 2019;28(8):2079–97. doi:10.1016/j.jstrokecerebrovasdis.2019.05.006
9. Yaghi S, Raz E, Yang D, Cutting S, Mac Grory B, Elkind M, et al. Lacunar stroke: mechanisms and therapeutic implications. J Neurol Neurosurg Psychiatry. 2021;92(8):823–30. doi:10.1136/jnnp-2021-326308
10. Yu C, An Z, Zhao W, Wang W, Gao C, Liu S, et al. Sex differences in stroke subtypes, severity, risk factors, and outcomes among elderly patients with acute ischemic stroke. Front Aging Neurosci. 2015;7:174. doi:10.3389/fnagi.2015.00174
11. Rutten-Jacobs LCA, Markus HS, UK Young Lacunar Stroke DNA Study. Vascular risk factor profiles differ between magnetic resonance imaging-defined subtypes of younger-onset lacunar stroke. Stroke. 2017;48(9):2405–11. doi:10.1161/STROKEAHA.117.017813
12. Teshome F, Baye BA, Wili W, Ifa M, Kune G. Determinants of stroke among adult hypertensive patients on follow up in Addis Ababa public hospitals, Ethiopia: a case control study. PLoS One. 2024;19(9):e0286845. doi:10.1371/journal.pone.0286845
13. Singh A, Bonnell G, De Prey J, Buchwald N, Eskander K, Kincaid KJ, et al. Small-vessel disease in the brain. Am Heart J

Plus. 2023;27:100277. doi:10.1016/j.ahjo.2023.100277
14. Nair R, Gandeti R, Chatterjee A, Chandran C, Gorthi SP, Puppala G, et al. Clinical, radiological and risk factor profiles of acute lacunar stroke in a developing country. Neurol Asia. 2021;26(1):41–7.
15. Arboix A, Estevez S, Rouco R, Oliveres M, García-Eroles L, Massons J. Clinical characteristics of acute lacunar stroke in young adults. Expert Rev Neurother. 2015;15(7):825–31. doi:10.1586/1473717.2015.1049997
16. Lee HY, Oh BH. Aging and arterial stiffness. Circ J. 2010;74(11):2257–62. doi:10.1253/circj.CJ-10-0910
17. Lioutas VA, Beiser A, Himali J, Aparicio H, Romero JR, DeCarli C, et al. Lacunar infarcts and intracerebral hemorrhage differences: a nested case-control analysis in the FHS (Framingham Heart Study). Stroke. 2017;48(2):486–9. doi:10.1161/STROKEAHA.116.014839
18. Regenhardt RW, Das AS, Lo EH, Caplan LR. Advances in understanding the pathophysiology of lacunar stroke: a review. JAMA Neurol. 2018;75(10):1273–81. doi:10.1001/jamaneurol.2018.1073
19. Tuttolomondo A, Maida C, Maugeri R, Iacopino G, Pinto A. Relationship between diabetes and ischemic stroke: analysis of diabetes-related risk factors for stroke and of specific patterns of stroke associated with diabetes mellitus. J Diabetes Metab. 2015;6(5):544–51.
20. Maida CD, Daidone M, Pacinella G, Norrito RL, Pinto A, Tuttolomondo A. Diabetes and ischemic stroke: an old and new relationship an overview of the close interaction between these diseases. Int J Mol Sci. 2022;23(4):2397. doi:10.3390/ijms23042397
21. Ntaios G, Milionis H, Vemmos K, Makaritsis K, Ferrari J, Strbian D, et al. Small-vessel occlusion versus large-artery atherosclerotic strokes in diabetics: patient characteristics, outcomes, and predictors of stroke mechanism. Eur Stroke J. 2016;1(2):108–13. doi:10.1177/2396987316647856
22. Harris S, Kurniawan M, Rasyid A, Mesiano T, Hidayat R. Cerebral small vessel disease in Indonesia: lacunar infarction study from Indonesian Stroke Registry 2012-2014. SAGE Open Med. 2018;6:2050312118784312. doi:10.1177/2050312118784312
23. Caplan LR. Lacunar infarction and small vessel disease: pathology and pathophysiology. J Stroke. 2015;17(1):2–6. doi:10.5853/jos.2015.17.1.2
24. Huber CC, Wang X, Wang H. Impact of cardiovascular diseases on ischemic stroke outcomes. J Integr Neurosci. 2022;21(5):138. doi:10.31083/j.jin2105138
25. Chou YL, Liou JT, Cheng CC, Tsai MC, Lin WS, Cheng SM, et al. The association of ischaemic stroke in patients with heart failure without atrial flutter/fibrillation. Heart. 2020;106(8):616–23. doi:10.1136/heartjnl-2019-315646