http://mnj.ub.ac.id/
**DOI:** 10.21776/ub.mnj.2023.009.02.9
**eISSN:** 2442-5001 **pISSN:** 2407-6724
**Accredited by DIKTI Decree No: 21/E/KPT/2018**

MALANG NEUROLOGY JOURNAL MNJ

RESEARCH ARTICLE OPEN ACCESS

# CLINICAL CHARACTERISTICS OF LACUNAR ISCHEMIC STROKE PATIENTS

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***Article History:***
*Received: November 4, 2022*
*Accepted: May 30, 2023*
*Published: July 1, 2023*

***Cite this as:***
*Khairunnisa AM, Amalia L, Eppy Buchori Aristiady, Nugraha HG, Hermawan AN. Clinical characteristics of lacunar ischemic stroke patients. Malang Neurology Journal; 2023.9:127-133. DOI: http://dx.doi.org/10.21776/ub.mnj.2023.009.02.9*

**ABSTRACT**

**Background:** Stroke is the leading causes of death and disability in the world. Ischemic stroke covered 85% of stroke types. Based on the subtypes of ischemic stroke, lacunar ischemic stroke encompassed 20% of them. Knowing the characteristics help physicians to diagnose patients clinically and offer management to treat risk factors.
**Objective:** This study aimed to know the characteristics of lacunar ischemic stroke based on patients risk factors, ischemic location on CT-scan, clinical syndrome, and NIHSS score.
**Methods:** Using retrospective analytical study with cross sectional approach, medical record data from 2019-2022 were collected from RSUP DR. Hasan Sadikin Bandung.
**Results:** From 60 patients, 35% (21) are 55-64 years old. Both sexes are equally distributed. 50 patients (83.3%) have multiple risk factors. Out of 60 patients, 57 (95%) have hypertension, 8 (13.3%) have diabetes mellitus, 44 (73.3%) have dyslipidemia, 6 (10%) have hyperuricemia, and 14 (23.3%) smoke. On admission, out of 60 patients, 34 (56.7%) have mild stroke, 23 (38.3%) have moderate stroke, 2 (3.3%) have moderate to severe stroke, and 1 (1.7%) has severe stroke. 44 (73.3%) out of 60 patients have pure motor hemiparesis. 41 (68.3%) out of 60 patients have basal ganglia ischemic.
**Conclusion:** Lacunar ischemic stroke patients were equally distributed in sex with peak incidence occur between 55-64 years old. Most patients have multiple risk factors, basal ganglia lesion, pure motor hemiparesis, and history of hypertension, dyslipidemia, and smoking. On admission, most patients have mild stroke, followed by moderate stroke.

**Keywords:** Lacunar ischemic, clinical characteristics, NIHSS

## Introduction

Stroke is the leading causes of death and disability in the world.[1] Based on its types, ischemic stroke reached 85% in worldwide prevalence.[2] According to TOAST, there are 5 subtypes of ischemic stroke, which are large-artery atherosclerosis, cardioembolism, small-vessel occlusion, stroke of other determined etiology, and stroke of undetermined etiology.[3] Lacunar ischemic stroke is defined based on its clinical picture and small non-cortical ischemic findings on CT-scan with the size between 2-15 mm in diameter. It is due to the occlusion of the penetrant branches of cerebral arteries.[4] Lacunar ischemic stroke filled 20% of ischemic stroke subtypes, worldwidely.[5,6] In Indonesia, a study was conducted in 18 hospitals in 2012-2014 resulted in lacunar ischemic to be 45% out of all ischemic stroke subtypes.[7]

The risk factors of stroke can be divided into two, which are modifiable and unmodifiable.[8,9] Modifiable factors, such as hypertension, diabetes mellitus, dyslipidemia, hyperuricemia, and smoking, and Unmodifiable factors, which are age, gender, race, and genetics, are involved in the pathogenesis of stroke.[10,11] Venkataraman et al stated that older age and hypertension are the most common risk factors for lacunar ischemic stroke. They also stated that cigarette smoking doubled up stroke risk.[12] Stroke also can be divided based on its severity using NIHSS.[13] NIHSS is used to quantify neurological deficits, treatment evaluation, and predict stroke outcome.[14]

Based on the ischemic location, lacunar ischemic stroke resulting in five most common syndromes, which are pure motor hemiparesis, pure sensory syndrome, sensorimotor syndrome, ataxic hemiparesis, and dysarthria-clumsy hand syndrome.[12] The most common syndrome from five is pure motor hemiparesis, followed by sensorimotor syndrome, ataxic hemiparesis, pure sensory syndrome, and last is dysarthria-clumsy hand syndrome.[12]

To date, research about clinical characteristics of lacunar ischemic stroke at Dr. Hasan Sadikin Bandung has yet been done, this research is expected to provide description of clinical characteristics of lacunar ischemic stroke to help physician diagnose lacunar ischemic stroke and as a consideration for more comprehensive management.

## Methods

This study aimed to know the characteristics of lacunar ischemic stroke based on patients' risk factors, ischemic

location on head CT-scan, clinical syndrome, NIHSS score by using retrospective analytical study with cross sectional approach and total sampling technique. This study was approved for exemption by Research Ethics Committee of Padjadjaran University Bandung, with approval number: 527/UN6.KEP/EC/2002. Medical record data from 2019-2022 were collected for samples from the neurology ward Dr. Hasan Sadikin Central General Hospital Bandung with the inclusion criteria includes patients diagnosed as lacunar ischemic stroke with the evidence of head CT-scan findings and clinical data. The exclusion criteria include patients with nonlacunar stroke or patients without the evidence of head CT-scan and clinical data. The risk factors included are hypertension, diabetes mellitus, dyslipidemia, hyperuricemia, smoking, age, gender, and amount of risk factors in each patient. NIHSS score by the time patient first arrived the hospital was also recorded. Head CT-scan findings and clinical syndrome that are proven and shown were also noted. The data were being processed, analyzed, and presented in tables.

# Results

There were 60 collected data which fulfilled this research inclusion criteria and exclusion criteria. As shown in table 1, the most prevalent age group is in the range of 55-64 years old with the percentage of 35% (21 patients), followed by 45-54 (30%), 65-74 (21.7%), and equal for both <45 and ≥75 age groups (6.7%) with mean age 58.65±10.38, while in sex, both are equally distributed. 50 patients (83.3%) have multiple risk factors and the rest 10 (16.7%) have single risk factor. Hypertension is the most common risk factor with the percentage of 95% (57 patients), followed by dyslipidemia (73.3%), smoking (23.3%), diabetes mellitus (13.3%), and hyperuricemia (10%) (Table 1).

**Table 1.** Distribution of Demography Characteristics

| Variable | N | Percentage | Mean±*SD* |
|---|---|---|---|
| **Age (years old)** | 60 | 100 | 58.65±10.38 |
| <45 | 4 | 6.7 | |
| 45-54 | 18 | 30 | |
| 55-64 | 21 | 35 | |
| 65-74 | 13 | 21.7 | |
| ≥75 | 4 | 6.7 | |
| **Sex** | | | |
| Male | 30 | 50 | |
| Female | 30 | 50 | |
| **Hipertension** | 57 | 95 | |
| **Diabetes Mellitus** | 8 | 13.3 | |
| **Dyslipidemia** | 44 | 73.3 | |
| **Hyperuricemia** | 6 | 10 | |
| **Smoking** | 14 | 23.3 | |
| **Risk Factors** | | | |
| Single | 10 | 16.7 | |
| Multiple | 50 | 83.3 | |

As shown in table 2, most patients have pure motor hemiparesis (73.3%) followed by sensorimotor syndrome (20%), equal for both ataxic hemiparesis and dysarthria-clumsy hand syndrome (3.3%), and no patient has pure sensory syndrome (table 2).

As shown in table 3, most ischemic involved basal ganglia (68.3%) followed by periventricular white matter (45%), internal capsule (15%), pons (13.3%), corona radiata (5%), equal for both thalamus and external capsule (3.3%), equal for lentiform nucleus, cerebellum, claustrum, and insula, and no ischemic found in mesencephalon (table 3).

**Table 2.** Distribution of Lacunar Syndrome

| Lacunar Syndrome | N | Percentage (%) |
|---|---|---|
| Pure Motor Hemiparesis | 44 | 73.3 |
| Pure Sensory syndrome | 0 | 0 |
| Sensorimotor Syndrome | 12 | 20 |
| Dysarthria-Clumsy Hand Syndrome | 2 | 3.3 |
| Ataxic hemiparesis | 2 | 3.3 |
| **Total** | **60** | **100** |

**Table 3.** Distribution of Ischemic Location on Head CT-Scan

| Ischemic Location | N | Percentage (%) |
|---|---|---|
| Basal ganglia | 41 | 68.3 |
| Thalamus | 2 | 3.3 |
| Lentiform Nucleus | 1 | 1.7 |
| Pons | 8 | 13.3 |
| Mesencephalon | 0 | 0 |
| Cerebellum | 1 | 1.7 |
| Periventricular White Matter | 27 | 45 |
| Claustrum | 1 | 1.7 |
| Insula | 1 | 1.7 |
| Internal Capsule | 9 | 15 |
| Corona Radiata | 3 | 5 |
| External Capsule | 2 | 3.3 |
| **Total** | **97** | |

As shown in table 4, on admission, with mean NIHSS score 5.6±3.91, most patients have mild stroke (56.7%), followed by moderate stroke (38.3%), moderate to severe stroke (3.3%), and severe stroke (1.7%) (table 4).

**Table 4.** Distribution of NIHSS Score

| Variable | N | Percentage (%) | Mean±*SD* |
|---|---|---|---|
| **NIHSS Score** | 60 | 100 | 5.6±3.91 |
| **NIHSS Category** | | | |
| Mild | 34 | 56.7 | |
| Moderate | 23 | 38.3 | |
| Moderate to severe | 2 | 3.3 | |
| Severe | 1 | 1.7 | |

# Discussion

Penetrant arteries, branches of cerebral arteries, can be occluded due to various factors such as age, gender, and modifiable risk factors such as hypertension, diabetes mellitus, dyslipidemia, hyperuricemia, and smoking. The occlusion is mainly because of the formation of lipohyalinosis and microatheroma. Lipohyalinosis is the thickening of media layer as well as fibrinoid deposition and smooth muscle hypertrophy which cause significant smaller arteries diameter and resulting in subcortical hypoperfusion. Mikroatheroma is deposition of fats and proliferation of fibroblasts, smooth muscle, and inflammatory cells which cause penetrant arteries occlusion. These mechanisms cause subcortical ischemia and can be manifested clinically into five most common lacunar ischemic syndrome, pure motor hemiparesis, pure sensory syndrome, sensorimotor syndrome, dysarthria-clumsy hand syndrome, and ataxic hemiparesis, based on the ischemic location.[15–19]

### Age

Data shows that most patients, 21 patients (35%), are in the range age of 55-64 years old (mean age 58.65±10.38 years). This result is corresponds with Arboix et al study in which they stated that lacunar stroke mostly occurred when the patients were 56-65 years old.[20]

This result is also corresponding with Riskesdas 2018 which stated that stroke prevalence is most common in age group of 55-64 years old and one of the research conducted by Roger et al which stated that stroke incidence is increasing as people aged and is doubled every 10 years after 55 years old. These research also prove that stroke is an aging disease.[10,11,21] Yousufuddin and young stated that cerebral vasculatory is undergo changes structurally and functionally with age which lead to cerebral vascular injury and decrease in cerebral functions.[10] This result is followed by 18 patients (30%) whose age were 45-54, 13 patients (21.6%) whose age were 65-74, 4 patients (6.6%) whose age were ≥75, and 4 patients whose age were <45.

**Sex**

Data shows that both sexes are equally distributed in which 30 patients each for female and male. This result is in accordance with the most prevalent range of age found in this study and kapral et al which stated that sex differences in stroke rely on age. The risk of stroke is lesser in younger women due to hormonal factor and as women reach menopause the incidence of stroke is increasing.[22,23] Estrogen can enhance vascular tone, vasodilators function, and suppress vascular inflammation which may explain as women menopause the stroke risk is the same as men.[24] Kapral et al stated that stroke risk in older women will eventually same or even higher than men.[23] Differ with the data results, Arboix et al stated that in most lacunar ischemic studies men are more prevalent than women, independent of the patient's age.[25] Sacco et al also stated that, using 491 identified lacunar stroke patients, men are more prevalent than women (252 men and 239 women).[26] Vyas et al stated that the incidence of stroke in women is lower than men and they also stated that this association varies by age.[27]

**Hypertension**

In this study, hypertension is the most prevalent risk factor with percentage of 95% (57 patients). Corresponding to cipolla et al, being the most important modifiable risk factor for stroke, stated the study, hypertension contributes directly to vascular alteration by promoting endothelial dysfunction, shear stress, and arterial stiffness which can lead to atherosclerosis plaque formation.[28] Wajngarten et al stated, using data from 30 studies, that hypertension is the most common risk factor in which 64% stroke patients were reported with hypertension.[29] Sabih et al also stated that hypertension is a major risk factor for both types of stroke and is identified in up to 90% of all stroke.[30] Arboix et al stated that hypertension contributes to lipohyalinosis formation in lacunar ischemic and being the major risk factor with higher prevalence (>70%) than other subtypes of stroke.[25] Fisher also found that hypertension was in 97% of lacunar stroke cases.[31]

**Diabetes**

Data shows that 8 patients (13.3%) have history of diabetes. This result is lower than Arboix et al study in which they stated that diabetes mellitus has 29% prevalence in lacunar ischemic stroke than in other subtypes of stroke. They also stated that diabetes mellitus is associated with poorer prognosis.[25] This result is also lower than Lau et al study in which in their study it is stated that, using 66 articles that met their inclusion criteria, diabetes prevalence to be 28% in stroke patients.[32] This result is also lower than Mantero et al study in which in their study it is stated that diabetes comprises 32% (48 out of 150 lacunar stroke patients).[33] Pikula et al stated that stroke patients with diabetes have poorer outcome and people with diabetes have 2.5-fold higher risk to develop stroke. They also stated that diabetes enhanced oxidative products which thought to disrupt arterial wall and promote atherosclerosis.[34] Nevertheless, studies show that diabetes mellitus has lower prevalence as a risk factor than hypertension in lacunar ischemic stroke.

**Dyslipidemia**

Dyslipidemia is either an increase in blood level of total cholesterol, triglycerides, LDL, or a reduce in blood level of HDL.[35] Data shows that 44 patients (73.3%) have history of dyslipidemia. Differ from this result, Sacco et al study found that hypercholesterolemia was present in 147 patients (29.9%) from 491 lacunar stroke patients which lower than this study result and higher than diabetes mellitus prevalence in their study.[26] Mantero et al also stated that dyslipidemia was found in 55 patients (36.7%) out of 150 lacunar stroke patients.[33] Nevertheless, These results are correspond with Wannamethee et al study, 7,638 men were used and were being followed-up at the mean period of 16.8 years where 343 of them developed stroke during the follow-up period, where they stated that an increase in HDL cholesterol level significantly decrease the risk of stroke, they also stated that there is an increased risk of stroke in men with higher total cholesterol level, though for triglycerides they did not see an increase risk of stroke associate.[36] Tanne et al also stated that, in a 21-year follow up study using 8,586 men in which 241 of deaths are due to ischemic stroke, subjects who developed ischemic stroke had lower HDL level.[37] Tian et al stated that HDL protects against vascular damage, whereas LDL triggers the formation of atherosclerosis.[38]

**Hyperuricemia**

Data shows that 6 patients (10%) have history of hyperuricemia. Zhong et al stated that, an increase in uric acid serum level is associated with higher risk to develop stroke, in dose-response relationships prospective studies where risk of stroke increases for every 1 mg/dL increases in serum uric acid levels by about 10%.[39] Zhao et al also stated that hyperuricemia leads to plaque formation by causing endothelial dysfunction which in turn starts atherosclerosis cascade.[40] Longo-Mbeza also stated that , using 418 random patients for a hospital-based study in Kinshasa, Congo, hyperuricemia is associated with an increase in stroke incidence by twofold ($P<0.01$).[41]

**Smoking**

Data shows that 14 patients (23.3%) have history of smoking. Differ with Sacco et al study, they stated that smoking is the second most prevalent risk factor after hypertension, the percentage in their study is higher than in this study, 159 patients (32.4%) out of 491 lacunar stroke patients had smoking as their risk factor, than in this study.[26] This result is corresponds with Staaf et al study, in which they found in their study that 50 patients (28.1%) from 178 lacunar ischemic stroke patients had smoking as their risk factor, although the percentage in their study is higher than in this study.[42] Pan et al stated that there is an increased risk of stroke by 12% for every additional 5 cigarettes per day compared to non-smokers, using 14 studies which include 303,134 participants where 4,050 of them had stroke.[43] The

chemical contents, such as nicotine, carbon monoxide, and oxidant gases, contribute to atherogenesis. Benowitz stated that oxidant chemicals in smoke reduce antioxidants and also increase oxidation processes which contribute to plaque formation.[44]

**Amount of risk factors**

Data shows that 50 of patients (83.3%) have multiple risk factors and the rest 10 (16.7%) have single risk factor. This result is corresponds with the study of Liu et al in which they stated that an increased in stroke risk is associated with multiple factors.[45] Yi et al also stated that, based on a population-based study, among 16,892 participants 14% of them were categorized as high-risk population for stroke and were associated with all eight risk factors for stroke (hypertension, diabetes, dyslipidemia, overweight/obesity, smoking, physical inactivity, family history of stroke, and atrial fibrillation) in which all contribute to atherosclerosis formation.[46] Zhao et al stated that, in an epidemiological study, the incidence rate of ischemic stroke is increasing at an annual rate 8.7% in which this result is coincides with the large increase of hypertension, smoking, overweight, dyslipidemia, diabetes mellitus, physical inactivity, diets low in fruit and vegetables, and high sodium intake.[46–53] According to Putaala et al, amount of risk factors influences the outcome of ischemic stroke patients, in which in the study it is stated that patients with no evidence of risk factors had lower mortality and lower risk for recurrent ischemic stroke. As to conclude, the study stated that the amount of risk factors in ischemic stroke patients is a useful prognostic tool.[54]

**Clinical Lacunar Syndrome**

Clinical syndrome in lacunar ischemic stroke include pure motor hemiparesis, pure sensory syndrome, sensorimotor syndrome, ataxic hemiparesis, and dysarthria-clumsy hand syndrome.[25] According to Boiten et al study, it is found that lacunar syndrome is an outstanding test to diagnose lacunar ischemic stroke with high specificity and sensitivity (>90%) without the evidence of head CT-scan.[55]

**Pure motor hemiparesis**

Data shows that 44 patients (73.3%) have pure motor hemiparesis syndrome and this is the most prevalent syndrome of all. The lesions occurred mostly in the basal ganglia, periventricular white matter, and pons. This result is in accordance with Arboix et al study in which they stated that, Using 227 lacunar ischemic patients, 125 of them (55%) were having pure motor hemiparesis, making pure motor hemiparesis the most common syndrome of all, although the percentage is lower than the percentage in this study.[20] The location involved is also almost similar, where in Arboix et al study the lesion involved mostly occurred in internal capsule, basal ganglia, and corona radiata.[20] The symptoms include weakness of the face, arm, and leg with no sensory disturbance.[25]

**Pure Sensory Syndrome**

There is no pure sensory syndrome identified in this study. Micheli et al stated that this syndrome is not common ranging between 6-7% and mostly involved thalamus.[56] The symptoms include sensory deficits, such as sensation disturbance of the face, arm, and leg contralaterally.[25] Arboix et al study in which from 227 patients with lacunar ischemic 42 (18%) of them were having pure sensory stroke, it is also stated that the associated sites were most frequent involved thalamic ventroposteriorlateral nucleus.[20] Another clinical study conducted by Arboix et al stated that, using 2,500 acute stroke patients in which 99 patients were identified with pure sensory syndrome, pure sensory syndrome contributes to 17.4% of lacunar syndrome.[57] Fewer patients with pure sensory syndrome were found in the study conducted by Chamorro et al in which 21 patients (7%) out of 337 patients diagnosed as lacunar ischemic stroke.[16]

**Sensorimotor Syndrome**

Data shows that 12 patients (20%) have sensorimotor syndrome. The lesions occurred mostly in the basal ganglia, periventricular white matter, and internal capsule. This result is corresponds with the study conducted by Chamorro et al in which they stated that, using 1,805 stroke patients from the Stroke Data Bank in which 337 (26%) of them were diagnosed as lacunar ischemic, sensorimotor syndrome is the second most prevalent syndrome of lacunar ischemic comprising 20% (63 patients) of all cases and mostly occurred in internal capsule and corona radiata.[16] The symptoms include weakness and numbness of the face, arm, and leg.[12]

**Dysarthria-clumsy hand Syndrome**

Data shows that 2 patients (3.3%) have dysarthria-clumsy hand syndrome. This syndrome occurred in basal ganglia, pons, and periventricular white matter. Differ with this result, Chamorro et al stated that this syndrome is the least prevalent among the five. Chamorro et al showed that out of 337 lacunar ischemic patients 18 of them (6%) were having dysarthria-clumsy hand syndrome.[16] This syndrome is presented with difficulty in speech and clumsy of the upper extremity contralaterally and usually involves the pons or internal capsule.[58] A study conducted by Arboix found that dysarthria-clumsy hand syndrome accounted for 6.1% (35) of lacunar syndrome from 2,500 acute stroke patients in a hospital-based prospective stroke registry.[25]

**Ataxic Hemiparesis**

Data shows that 2 patients (3.3%) have ataxic hemiparesis syndrome. This syndrome involved pons and cerebellum. Differ with this result, A study conducted by Chamorro et al showed that 33 patients (10%) out of 337 patients diagnosed as lacunar stroke were having ataxic hemiparesis syndrome which has a higher percentage than this study.[16] Gore et al stated that this syndrome involves the internal capsule, pons, or corona radiata which cause partial weakness of the contralateral face and leg and impairment of coordination of the contralateral limb.[58]

**Ischemic Location on Head CT-Scan**

Data shows that most of the ischemic occurred in basal ganglia with percentage of 68.3% (41 patients). According to Chamorro et al study, the ischemic involved were associated with the syndrome created. In this study, it is found that most of the patients have multiple ischemic that involved different location of the brain in which 41 patients (68.3%) have basal ganglia lesion, 27 patients (45%) have periventricular white matter lesion, 9 patients (15%) have internal capsule lesion, 8 patients (13.3%) have pons lesion, 3 patients (5%) have corona radiata lesion, 2 patients (3.3%) for each lesion involving thalamus and external capsule, and 1 patients (1.6%) for each lesion involving caudate nucleus, lentiform nucleus, cerebellum, claustrum, and insula.

This result is different from Chamorro et al study in which in their study corona radiata ischemic is the most common of all.[16]

**NIHSS score**

NIHSS score is widely use to assess the severity of stroke, treatment outcome, and outcome of stroke.[59] The obtained data shows that, on admission to hospital, there are 34 patients (56.7%) with mild stroke, 23 patients (38.3%) with moderate stroke, 2 patients (3.3%) with moderate to severe stroke, 1 patients (1.7%) with severe stroke (mean score 5.6±3.91). This result corresponds with Perera et al study in which they found, using 229 ischemic stroke patients in which 130 of them were identified as lacunar ischemic stroke, the average of NIHSS to be 5.34 which is lower compared to nonlacunar stroke (6.6). The study conducted by Perera et al showed that lacunar ischemic stroke has lesser severity compared to nonlacunar stroke based on the NIHSS score.[60] This result is different with Yao et al study which stated that most lacunar ischemic stroke has no symptoms (111 patients out of 220) and followed by mild stroke (88 patients out of 220).[14] According to Hinkle et al, it was found that by knowing the category of NIHSS physicians can predict the treatment response, for example when given rt-PA, patients with NIHSS score >22 had a 17% risk of intracranial hemorrhage, whereas patients with NIHSS score <10 had a 3% risk.[61] Differ from this result, according to Arba et al study, patients with NIHSS score <7 are tend to have lacunar ischemic stroke rather than other subtypes of ischemic stroke.[62] According to Baumgartner et al, The difference is possibly because patients with repeated lacunar ischemic stroke have multiple and larger ischemic location which causing higher severity.[63]

## Conclusion

Lacunar ischemic stroke in neurology ward RSUP Dr. Hasan Sadikin Bandung was equally distributed in sex, mostly occurred in patients aged 55-64 years old, most of them have multiple risk factors in which hypertension becomes the most prevalent followed by dyslipidemia, smoking, diabetes mellitus, and hyperuricemia. The most common syndrome was pure motor hemiparesis followed by sensorimotor syndrome, dysarthria-clumsy hand syndrome, ataxic hemiparesis, and pure sensory syndrome. The most prevalent ischemic locations involved basal ganglia followed by periventricular white matter, internal capsule, and pons. On admission to hospital, lacunar ischemic stroke patients mostly have mild stroke, followed by moderate stroke. These characterstics are expected to help physicians diagnose lacunar ischemic stroke clinically and offer a more comprehensive management.

## Acknowledgement

The authors gratitude toward Padjadjaran University and RSUP Dr. Hasan Sadikin, Bandung, West java, Indonesia for facilitating this research.

## Conflict of Interest

There is no conflict of interest in this research.

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