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Original Article

# Profile of Non-Hemorrhagic Stroke Patients Who Received Endovascular Stenting Services at Dr. Kariadi General Hospital Semarang

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**Introduction:** Endovascular stenting (ES) is an alternative therapy to carotid endarterectomy (CEA) and best management therapy (BMT) for intracranial and extracranial arterial stenosis with or without symptoms. Atherosclerosis can cause non-hemorrhagic stroke, and the risk factors include diabetes mellitus, dyslipidemia, smoking, hypertension, and advanced age. **Objective:** This study aimed to determine the profile of non-hemorrhagic stroke patients who received ES services at Dr. Kariadi General Hospital, Semarang. **Method:** This research used a descriptive method with sampling carried out sequentially using electronic patient medical record data from January 2023 to November 2024. **Result:** ES services were obtained for 67 patients, of whom 39 were men (58.2%). The largest age groups were between > 50-60 years and > 60-70 years, accounting for 37.3%. The stenosis in the proximal vertebral artery was performed by ES in 70.1% patients. ES was performed on 62.7% patients, with an average stenosis degree of 59.8% in the 50%–69% range (moderate to severe stenosis group). Risk factors for atherosclerosis in this study included hypertension in 67.2% patients and dyslipidemia in 52.2%. There were 71.6% of patients who did not have risk factors for diabetes mellitus. In this study, only 2 patients' data from medical records were examined for smoking risk factors. **Conclusion:** Non-hemorrhagic stroke patients who received endovascular stenting services at Dr. Kariadi General Hospital, Semarang, were men in their 50s and 60s, with lesions in the proximal vertebral artery with an average stenosis degree of 59.8%. Risk factors included hypertension, age, and dyslipidemia.

**Keywords:** Endovascular stenting, Non-hemorrhagic stroke, Patient profile, Risk factors

**Highlights**
- This study describes profiles of patients who received endovascular stenting services
- A descriptive method study was selected to offer a thorough overview

## Introduction

Stroke is the third most common cause of disability worldwide, and the second leading cause of death. Stroke is generally classified into non-hemorrhagic stroke (NHS) and hemorrhagic stroke (HS). Non-hemorrhagic stroke, also known as ischemic stroke, occurs due to a blockage in the blood vessels of the brain. Globally, approximately 68% of all strokes are non-hemorrhagic(ischemic).[1] Across several studies, the reported prevalence of stroke ranges from 147 to 922 cases per 100,000 population.[2,3] One-third of patients with non-hemorrhagic stroke die, while another is disabled.[4]

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Atherosclerosis is the hardening of the arteries, which can cause heart disease and stroke. The process usually begins in childhood and continues as people age. In stroke, atherosclerosis can occur in extracranial blood vessels (Extra Cranial Atherosclerosis Stenotic/ECAS) and in intracranial blood vessels (Intra Cranial Atherosclerosis Stenotic/ICAS). Atherosclerotic disease in extracranial blood vessels (ECAS), particularly carotid artery stenosis, accounts for about 18%–25% of non-hemorrhagic strokes.[5]

Atherosclerotic disease is directly related to lesion severity.[6] Stenosis greater than 75% has a 2%-5% risk of resulting in a non-hemorrhagic stroke during the first year.[7,8] The risk of subsequent stroke after a transient ischemic attack (TIA) is 12%-13% during the first year and increases 30%-37% within 5 years.[8,9]

One of the most common causes of stroke worldwide is intracranial atherosclerotic stenosis (ICAS) and is associated with recurrent stroke. Intracranial atherosclerotic stenosis is especially common in Hispanic, Indian, Black, Asian, and some Arab populations. The incidence of ICAS is likely to rise as the population continues to grow. The most important factor causing strokes worldwide is stenosis of major arteries like the middle cerebral artery and vertebral artery. Even after adequate pharmacological therapy, severe stenosis of 70%-99% carries a 25% annual risk of recurrent stroke.[9,10] Approximately in 7% within the first year of diagnosis with stenosis of more than 60% have been shown to experience impaired hemodynamic status, leading to recurrent ischemic stroke or TIA. [11,12]

Medical management, namely antiplatelet therapy, lifestyle management, and controlling risk factors, is the first-line therapy for ECAS/ICAS, which helps prevent recurrent non-hemorrhagic/ischemic stroke and transient ischemic attack (TIA).[13]

The combination of Clopidogrel and aspirin in the CHANCE (Clopidogrel in High-risk patients with Acute Non-disabling Cerebrovascular Events) study tended to lower the risk of TIAs and recurrent strokes in patients with minor strokes and ICAS compared with aspirin alone, but the difference was not statistically significant. Cilostazol also failed to show significant efficacy in preventing the development of ICAS or new ischemic lesions.[14,15] Recurrent attacks in patients with symptomatic intracranial stenosis are not sufficient to be prevented with medical management alone.[12,16]

Balloon angioplasty, with or without intracranial stenting, can also be used to manage ICAS. Percutaneous transluminal angioplasty and stenting (PTAS) is usually recommended by Neurologists for patients with symptomatic ICAS to prevent stroke.[17,18]

Endovascular therapy, such as balloon angioplasty, since 1980 has been an option for symptomatic intracranial stenosis. Intracranial angioplasty initially carries a high risk of complications, but new neurointerventional technology has improved the success rate of this procedure method. [12,16] Advances in technology have enable safer endovascular procedures with higher success rates. Patients at high risk and with poor prognosis can undergo intracranial angioplasty if they are only receiving pharmacological therapy.[11,12]

Figure 1 below shows an endovascular intervention consisting of angioplasty followed by stent placement to prevent recurrent stroke. In these patients, angioplasty with stent placement is a reasonable treatment option for preventing massive ischemic stroke.

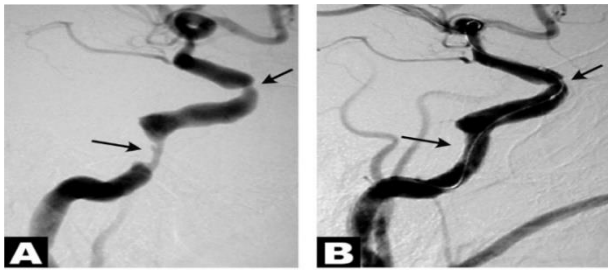

Figure 1. Intracranial angioplasty and stent placement for cerebral atherosclerosis.

The SAMMPRIS (Stenting and Aggressive Medical Management for Preventing Recurrent Stroke in Intracranial Stenosis) trial showed that the 1-year stroke or death rate was 12.6% in symptomatic ICAS patients with stenosis greater than 70%.[19,20] Stenting may still be required in cases of severe stenosis.[17,21]

ECAS management can be with carotid endarterectomy (CEA), carotid artery stenting (CAS), and optimal medical therapy (OMT). The choice of treatment largely depends on symptom status, individual factors, efficacy, risk of complications, and stenosis severity.[22]

Based on the above introduction, several problems can be formulated: non-hemorrhagic/ischemic stroke is a stroke case with the most common causes being intracranial atherosclerotic stenosis (ICAS) and extracranial atherosclerotic stenosis (ECAS), which require endovascular management in addition to conservative procedures (medication and lifestyle changes). Endovascular therapy for managing intracranial atherosclerotic stenosis (ICAS) and extracranial atherosclerotic stenosis (ECAS) includes angioplasty, stenting, or a combination of both. The profiles of non-hemorrhagic stroke (SNH) patients who received endovascular stenting services at Dr. Kariadi General Hospital, Semarang, have not yet been studied. The results of this study are expected to provide initial information needed for researchers, particularly on ES services, and to complement data sources for health institutions. It can serve as a basis for decision-making and further research to advance medical science, particularly in local and global neurointerventional science.

## Objective

To date, no research has reported the profile of stroke patients who received endovascular stenting services at Dr. Kariadi General Hospital, Semarang. This study aimed to determine the profile of non-

hemorrhagic stroke patients who underwent endovascular stenting at Dr. Kariadi General Hospital, Semarang.

## Method

This research used a descriptive method to describe the phenomena in terms of risk factors and effects/outcomes, with sampling conducted sequentially after meeting the inclusion and exclusion criteria. The research used electronic patient medical record data from January 2023 to November 2024.

The inclusion criteria of the study were stroke patients with non-hemorrhagic stroke (ischemic/infarction), wether it was their first time or recurrent, whose diagnosis was proven by computed tomography scan (CTScan) or magnetic resonance imaging (MRI), with or without other non-invasive supporting examinations such as transcranial doppler (TCD), computed tomography angiography (CTA), or magnetic resonance angiography (MRA). The exclusion criteria included hemorrhagic stroke patients, patients with neurological deficits not supported by imaging evidence, and patients with a history of endovascular angioplasty or a combination of endovascular stenting and angioplasty.

In this study, the operational definitions of stenosis location and degree of stenosis are determined based on the results of invasive angiography, specifically digital subtraction angiography (DSA), which are recorded in the medical record. The variable for stenosis location is classified into intracranial and extracranial. The degree of stenosis variable is classified into the following categories: < 30%, 30%–49%, 50%–69%, and 70%–99%. The percentage of intracranial artery stenosis can be determined using the Warfarin-Aspirin Symptomatic Intracranial Disease (WASID) method. The percentage of intracranial artery stenosis is calculated as: Percentage of stenosis = [(1 − (D stenosis / D normal))] × 100, where D stenosis is the diameter of the artery at the site of the most severe stenosis and D normal is the diameter of the proximal normal artery. The following criteria determine d normal: for the middle cerebral, vertebral, and basilar arteries, the diameter of the widest, non-tortuous segment of the proximal part of the artery is used (first choice). The degree of stenosis in extracranial arteries can be measured using the NASCET criteria, which include measuring the narrowest and normal lumen diameters of the cervical segment of the internal carotid artery (proximal segment). The percentage of stenosis is calculated with the formula (b-a)/b, where a is the narrowest lumen diameter and b is the normal lumen diameter of the cervical segment of the internal carotid artery (proximal segment).

The age variable in this study was classified into > 18-30 years, > 30-40 years, > 40-50 years, > 50-60 years, > 60-70 years, > 70-80 years, and > 80-90 years.

## Result

This study found that endovascular services were performed on 259 patients from January 2023 to November 2024. The procedures included stenting in 101 patients (39%), angioplasty in 124 patients (47.9%), and a combination of stenting and angioplasty in 34 patients (13.1%). Stenting was performed in the non-hemorrhagic stroke group (ischemic/infarction), which met the study's inclusion criteria, in 67 patients (66.3%) and in 34 patients (33.7%) with non-hemorrhagic stroke, consisting of 39 men (58.2%) and 28 women (41.8%).

Based on the age distribution in table 1, endovascular services were reported to be performed more frequently in those aged 60 to 60 years and 60 to 70 years.

Based on the location of the stenosis, this study reported the location of the artery that experienced stenosis and stenting in the extracranial segment, mainly in the proximal segment of the vertebral artery (70.1%).

The diameter of the artery with stenosis and stents was examined, and this study found that all stenting procedures were performed in the large vessel, the carotid and vertebral arteries. Additionally, the study found that stenting was performed in 100% of patients with large vessels.

This study reported that stenting was primarily performed in the moderate-severe stenosis group and the severe stenosis group, but it also noted that 3 patients with an average of 45 % moderate stenosis received endovascular treatment. No reason has been found in the electronic medical records why patients received it.

Risk factors for atherosclerosis other than age in this study obtained from patients who had a history of hypertension 67.2%, dyslipidemia was found in 52.2% patients and patients 71.6% without diabetes mellitus. There were only two patient medical records that explored the risk factor of smoking, but it could not clearly state the actual percentage of patients with this risk factor.

Table 1. Research result

| Variable | Number of patients (n) | Percentage (average %) |
|---|---|---|
| **Age (years)** | | |
| >18-30 | 0 | 0 |
| > 30-40 | 1 | 1.5 |

Table 1 continued. Research result

| Variable | Number of patients (n) | Percentage (average %) |
|---|---|---|
| > 40-50 | 11 | 16.4 |
| > 50-60 | 25 | 37.3 |
| > 60-70 | 25 | 37.3 |
| > 70-80 | 3 | 4.5 |
| > 80-90 | 2 | 3 |
| **Gender** | | |
| Male | 29 | 58.2 |
| Female | 38 | 41.8 |
| **Location of stenosis** | | |
| Intracranial | 0 | 0 |
| Extracranial | 67 | 100 |
| - Internal carotid artery | 19 | 21.45 |
| - External carotid artery | 1 | 1.5 |
| - Vertebral artery | 47 | 70.1 |
| **Arterial diameter** | | |
| Large vessel | 67 | 100 |
| Non-large vessel | 0 | 0 |
| **Degree of stenosis** | | |
| Mild (< 30%) | 0 | 0 |
| Moderate (30%-49%) | 3 | 4.5/ (45) |
| Moderate-Severe (50%-69%) | 42 | 62.7/(59.8) |
| Severe (70%-99%) | 22 | 32.8/(76.1) |
| **Hypertension** | | |
| Yes | 45 | 67.2 |
| No | 22 | 32.8 |
| **Dyslipidemia** | | |
| Yes | 35 | 52.2 |
| No | 32 | 47.8 |
| **Diabetes mellitus** | | |
| Yes | 19 | 28.4 |
| No | 48 | 71.6 |
| **Smoking** | Incomplete data | Incomplete data |

## Discussion

In the results of this study (Table 1), it was found that non-hemorrhagic stroke patients who underwent endovascular stenting were predominantly in the > 50 - 60 year and > 60 - 70-year age groups, each comprising 37.3% of the sample. Atherosclerotic plaque formation usually does not present clinically until the fourth decade of life, and significant progression is most pronounced between the sixth and seventh decades.[23] Similar findings were also reported by researchers, who observed that among 184 eligible patients, the 64 patients in the rescue angioplasty or stenting (PTAS) group had a mean age of 61.1 years. In contrast, the 120 patients in the non-PTAS group had a mean age of 62.5 years.[24] The higher rate of endovascular stenting in men in this study may be attributed to the higher incidence in men compared with women in both White and Black populations, although the difference is not statistically significant.[25]

Endovascular stenting procedures were performed extracranially in 47 patients (70.1%), specifically in the proximal vertebral artery segment. Existing evaluations of the efficacy and safety of stenting or angioplasty for intracranial artery stenosis support the selection of the extracranial stenting location. Extracranial carotid stenting procedures are common and appear safe, with a low complication rate.[26] However, stenting or angioplasty for intracranial artery stenosis remains controversial and is recommended only as Class IIb, Grade C evidence.[27]

We found that all endovascular stenting procedures were performed in large vessels. Stenosis in large vessels due to atherosclerosis of large extracranial or intracranial arteries is often identified as a potential etiology of non-hemorrhagic stroke (ischemic/infarction) and transient ischemic attacks. Atherosclerosis of large extracranial or intracranial arteries can generally be classified based on the anatomical location of the affected vessels. [28]

The higher frequency of endovascular stenting among patients with hypertension is consistent with research reports showing a significant association ($p < 0.001$) in both White patients (511 cases, 55.5%) Black patients (133 cases, 70.7%). It was also reported that hypertension was a significant risk factor ($p = 0.04$) for non-hemorrhagic stroke (483 cases, 60.1%) and hemorrhagic stroke (110 cases, 50.2%).[25]

Endovascular stenting was most often performed in patients with dyslipidemia (52.2%). Dyslipidemia is

characterized by an imbalance between HDL and LDL cholesterol levels in the blood. The higher frequency of endovascular stenting among patients with dyslipidemia is supported by research reports showing that high LDL-C levels and low HDL-C levels are associated with an increased risk of non-hemorrhagic stroke. In contrast, the association with high triglyceride levels remains unclear. [29]

In this study, endovascular stenting was most frequently performed in non-hemorrhagic stroke patients, who had a mean stenosis degree of 59.8%. Stenosis > 50% is considered clinically significant. According to the flowchart for carotid stenosis management published by cardiologists and European vascular surgeons[30] for stenosis degrees of 59.8% and 76.1%, endovascular stenting with best management therapy (BMT) is an alternative to carotid endarterectomy (CEA).

Endovascular stenting was most often performed in non-hemorrhagic stroke patients without diabetes mellitus (71.6%). In a study involving 1,254 patients, reported diabetes mellitus was a significant risk factor for non-hemorrhagic stroke ($p < 0.001$) in both White patients (126 patients, 13.7%), and Black patients (64 patients, 34.0%). [25]

In this study, the data on smoking risk factors were incomplete because out of the 67 patients involved, only two medical records included information on smoking risk factors. Therefore, this study could not clearly report the percentage of patients with this risk factor. In another study involving 1,254 patients, it was reported that smoking was a significant risk factor for non-hemorrhagic stroke ($p < 0.001$) in both White patients (617 patients, 74.3%) and Black patients (87 patients, 51.5%). [25]

The previous study about atherosclerosis reported the risk factors as diabetes mellitus, dyslipidemia, smoking, hypertension, and age. However, this study found that non-hemorrhagic stroke patients who received endovascular stenting services at Dr. Kariadi General Hospital in Semarang had risk factors, including the 50s and 60s age group, hypertension, and dyslipidemia. There were no differences with other studies; 71.6% patients had no risk factors for diabetes mellitus, and only two patients' medical records indicated smoking as a risk factor.

The limitations of this study come from its reliance on data recorded in electronic patient records, which prevents a comprehensive analysis of the risk factors under study. Like other descriptive studies, it has the advantage of observing the subject's natural conditions over a short period of time and with a relatively small number of subjects.

## Conclusion

In this study, we reported results among non-hemorrhagic stroke patients who received endovascular stenting services at Dr. Kariadi General Hospital in Semarang. These patients were men in their 50s and 60s, with stenosis in the proximal vertebral artery averaging 59.8%. Risk factors included hypertension and dyslipidemia.

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### Conflict of Interest
The authors declared no conflict of interest.

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### Author contribution
All authors contributed to this study, including conceptualization, patient management, project administration, and supervision.

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