

## Original Research Article

# Characteristics and findings of digital subtraction angiography and magnetic resonance imaging in neurological patients: a cross-sectional study

Fritz Sumantri, Dini Adriani, Ratih W. Novitasari, Veinels C. Lomboan,  
Leny Kurnia, Merlin P. Kastilong\*

Department of Neurovascular Intervention, Pelni Hospital, West Jakarta, DKI Jakarta, Indonesia

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### \*Correspondence:

Dr. Merlin P. Kastilong,

E-mail: merlinkastilong07@gmail.com

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## ABSTRACT

**Background:** Stroke is a major health concern worldwide with significant rates of mortality and morbidity. Asian population suffers from increasing incidence of stroke. Various imaging modalities have been developed for the diagnosis of stroke and neurological diseases. This study aims to compare the use of digital subtraction angiography (DSA) and magnetic resonance imaging (MRI) in neurological patients, underscoring particularly in ischemic stroke patients.

**Methods:** This cross-sectional descriptive study was performed from February to November 2023. Data was taken from medical records. All patients visiting the outpatient care unit of a hospital in Jakarta who underwent DSA and MRI were included in the study. The data taken included the patient's name, medical record number, age, gender, MRI results, DSA results, and diagnosis. Diagnosis was established through history taking and physical examination.

**Results:** Of 500 subjects included in the study, most subjects were male (50.6%) aged 20 – 60 years old (75.6%) abnormal MRI and DSA results (84.6% and 90.6%, respectively). Ischemic stroke was the leading diagnosis (50.8%). MRI and DSA results showed 79.6% agreement of all cases.

**Conclusions:** Although MRI showed normal results, DSA could show abnormal results. This points out DSA superiority in detecting vascular abnormality compared to MRI.

**Keywords:** Digital subtraction angiography, Magnetic resonance imaging, Ischemic stroke, Comparison

## INTRODUCTION

Out of all neurological diseases, stroke still becomes a major health concern worldwide. Stroke causes significant rates of mortality and morbidity, particularly in developing countries. Indonesia, a member of Southeast Asia regions, suffers a big impact from stroke incidence. The increasing incidence of stroke stems from the shift towards an unhealthy lifestyle, e.g. sedentary lifestyle, smoking, and alcohol consumption, along with the escalation of pollution and humid hot climate.<sup>1,2</sup> In the Asian population, intracerebral atherosclerosis is the leading

cause of stroke in contrast to the Caucasian population.<sup>3</sup> A study in a tertiary hospital in Indonesia reported that large vessel occlusion is the leading cause of stroke in the Indonesian population.<sup>4</sup> To establish the diagnosis of stroke, imaging is vital to be performed immediately as the prognosis is time-dependent. Computed tomography (CT) and magnetic resonance imaging (MRI) are the most commonly used imaging for stroke.<sup>5</sup> Digital subtraction angiography (DSA) is an imaging technique of the blood vessel's lumen to identify the site of large vessel occlusion and establish the etiology of stroke.<sup>6</sup> The use of DSA is growing these days as it shows more benefits for the

diagnosis of stroke.<sup>7</sup> DSA is established as a gold standard technique for the diagnosis of vascular disorders. Despite being an invasive technique, DSA does not frequently cause complications. DSA is also superior to MRI or CT angiography in diagnosing subarachnoid hemorrhage.<sup>8</sup> Therefore, this study aims to compare the use of DSA and MRI in neurological patients, underscoring particularly in ischemic stroke patients.

## METHODS

### Study design

A cross-sectional study was performed from February to November 2023 at Pelni Hospital, Jakarta, Indonesia. This study used secondary data from medical records. Ethical approval was obtained from Institutional Review Board of the hospital. Informed consent was not necessary since the data was taken from medical records and no patient's data was published in this study.

Subjects were included consecutively from the database dated from February to November 2023. All patients visiting the outpatient care unit of the hospital who underwent DSA and MRI were included in the study. Patients with incomplete data were excluded from the study. This study employed a total sampling method, including all patients who met the eligibility criteria from March to November 2023, totaling 500 subjects. The data taken included the patient's name, medical record number, age, gender, MRI results, DSA results, and diagnosis.

Diagnosis was established through history taking and physical examination. Data were documented and coded.

### Statistical analysis

Descriptive analysis was performed with SPSS version 26.0 (SPSS Inc, Chicago, Illinois, United States). Data were presented in frequency and percentage.

## RESULTS

A total of 500 subjects were recruited for the study. The sociodemographic and clinical characteristics of the subjects are shown in Table 1. Most subjects were male (253 subjects, 50.6%) aged 20-60 years old (75.6%). Both MRI and DSA results were mostly abnormal (423 subjects (84.6%) and 453 subjects (90.6%), respectively). The most common diagnosis was ischemic stroke (50.8%). The sociodemographic and clinical characteristics based on diagnosis are shown in Table 2.

Ischemic stroke patients were mostly male (63.8%) while non-ischemic stroke patients were mostly female (63%). Both ischemic stroke and non-ischemic stroke patients mostly aged 20 – 60 years old (73.6% vs 77.6%), had abnormal MRI (92.1% vs 76.8%) and DSA results (94.9% vs 86.2%). The comparison of MRI and DSA results is shown in Table 3. A total of 77.4% of the patients had both abnormal MRI and DSA results. Only 2.2% of the patients had both normal MRI and DSA results. The similarity of MRI and DSA result was observed in 201 subjects (40.2%).

**Table 1: Sociodemographic and clinical characteristics of the subjects (n=500).**

Characteristics	Frequency (%)
<b>Gender</b>	
Male	253 (50.6)
Female	247 (49.4)
<b>Age (in years)</b>	
11– 19	3 (0.6)
20 – 60	378 (75.6)
>60	119 (23.8)
<b>MRI results</b>	
Normal	77 (15.4)
Abnormal	423 (84.6)
<b>DSA results</b>	
Normal	47 (9.4)
Abnormal	453 (90.6)
<b>Diagnosis</b>	
Ischemic stroke	254 (50.8)
Vertigo	115 (23)
Cephalgia	107 (21.4)
Hemorrhagic stroke	10 (2)
Space occupying lesion	5 (1)
Arteriovenous malformations	4 (0.8)
Seizure	3 (0.6)
Hemifacial spasm	1 (0.2)
Dementia	1 (0.2)

DSA = digital subtraction angiography; MRI = magnetic resonance imaging.

**Table 2: Sociodemographic and clinical characteristics based on diagnosis (n = 500).**

Characteristics	Frequency (%)	
	Ischemic stroke (n=254)	Non-ischemic stroke (n=246)
<b>Gender</b>		
Male	162 (63.8)	91 (37)
Female	92 (36.2)	155 (63)
<b>Age (in years)</b>		
11-19	1 (0.4)	2 (0.8)
20-60	187 (73.6)	191 (77.6)
>60	66 (26)	53 (21.5)
<b>MRI results</b>		
Normal	20 (7.9)	57 (23.2)
Abnormal	234 (92.1)	189 (76.8)
<b>DSA results</b>		
Normal	13 (5.1)	34 (13.8)
Abnormal	241 (94.9)	212 (86.2)

DSA = digital subtraction angiography; MRI = magnetic resonance imaging.

**Table 3: Comparison of magnetic resonance imaging and digital subtraction angiography results (n = 500).**

MRI	DSA		Total (%)
	Abnormal (%)	Normal (%)	
<b>Abnormal</b>	387 (77.4)	36 (7.2)	423 (84.6)
<b>Normal</b>	66 (13.2)	11 (2.2)	77 (15.4)
<b>Total</b>	453 (90.6)	47 (9.4)	500 (100)

DSA = digital subtraction angiography; MRI = magnetic resonance imaging

## DISCUSSION

This study's findings are in line with a previous study in Indonesia that most stroke patients are men with age 60 years old.<sup>4</sup> A study in young adult's population showed similar findings that men predominate the stroke patients. The median age of young adults with stroke was 37 years old with most stroke patients aged 36–45 years old.<sup>7</sup> Men are known to have riskier lifestyles compared to women, i.e. smoking and alcohol consumption. The incidences of hypertension, dyslipidemia, metabolic syndrome, coronary artery diseases, and atrial fibrillation are also higher in men.<sup>4,7</sup>

Abnormal DSA results are higher than MRI results in both ischemic stroke and non-ischemic stroke patients. Both DSA and MRI showed 79.6% agreement in results while the rests are contradictory. DSA is known as the gold standard examination for the diagnosis of vascular abnormalities. The extend of DSA capability is visualizing up to 1 mm artery in the brain. In addition, DSA can visualize the blood flow of the main cerebral artery and its collateral. The advantage of using DSA against CT and MRI is that it can detect the feeding artery in cerebral arteriovenous malformations along with presence of aneurysm and venous drainage.<sup>7</sup>

A study comparing the use of magnetic resonance angiography (MRA) and DSA for thrombectomy showed that DSA is superior to MRA for identifying large vessel occlusion in stroke patients.<sup>9</sup> Another study comparing the

use of high-resolution (HR)-MRI and DSA for cerebral arterial diseases reported that DSA and HR-MRI are comparable for the identification and diagnosis of cerebral arterial diseases.<sup>10</sup> For basilar artery stenosis, DSA is deemed more superior to MRI because it can assess the perfusion status better, show delayed perfusion, and examine retrograde and antegrade collateral flow.<sup>11</sup> DSA is also superior to CT angiography (CTA) for vertebral artery pathology while they are comparable for basilar artery pathology.<sup>12</sup>

While some studies sang praises for DSA, a study comparing 3D MRI and DSA showed that 3D HR-MRI is superior to DSA in diagnosing intracranial artery stenosis.<sup>13</sup> A previous study which compared the use of DSA, CTA, MRA, and Doppler ultrasonography revealed that DSA underrated mild to moderate stenosis of intracerebral artery.<sup>14</sup> In addition, while both DSA and MRI showed similar degree of stenosis, HR-MRI can identify stenosis in smaller vessels.<sup>10,13</sup> However, the recommendation is that 3D HR-MRI serves as a complement to DSA, not replacing DSA as the gold standard diagnostic tool for vascular diseases.<sup>13</sup>

Limitations of this study is the retrospective design as well as no analysis on the safety of DSA. Furthermore, the diagnoses were established based on clinical judgement without pathological confirmation. While this study compares ischemic stroke and non-ischemic stroke groups, the non-ischemic group consisted of various neurological disorders. Further study is necessary to establish the

comparison of DSA and other imaging modalities' accuracy, particularly in Asian population.

## CONCLUSION

This study highlights the use of DSA in neurological patients in Indonesia. Although MRI showed normal results, DSA could show abnormal results. This points out DSA superiority in detecting vascular abnormality compared to MRI

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