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Original Article

Funduscopic and Transcranial Doppler Profile of the Ophthalmic Artery in Stroke Patients with Hypertensive Retinopathy Cipto Mangunkusumo National Hospital

Dini Adriani[1], Eva Dewati[1], Freddy Sitorus[1], Ni Nengah Rida Ariani[1], Dinda Diafiri[1], Tiara Kasih[1], Mohammad Kurniawan[1] ✉

[1] Department of Neurology, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo National Hospital, Jakarta, Indonesia

Corresponding Author:
Mohammad Kurniawan
Department of Neurology, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo National Hospital, Jakarta, Indonesia
Email: m.kurniawan@ui.ac.id

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Introduction: Hypertensive retinopathy (HR) is a manifestation of chronic vascular damage and is increasingly recognized as a predictor of stroke. Funduscopy and Transcranial Doppler (TCD) examination of the ophthalmic artery may offer non-invasive insight into cerebrovascular health. **Objective:** To describe the demographic, funduscopic, and ophthalmic artery hemodynamic profiles in stroke patients with hypertensive retinopathy using Transcranial Doppler. **Method:** A cross-sectional descriptive study was conducted from May 2022 to May 2025 at Cipto Mangunkusumo National Hospital, involving 67 ischemic stroke patients with HR. Retrospective data were collected from medical records, including sociodemographics, fundus classification based on Wong and Mitchell, and Pulsatility Index (PI) values of the ophthalmic artery from TCD. **Result:** Mild hypertensive retinopathy is prevalent in ischemic stroke patients, and elevated ophthalmic artery PI values suggestive of small-vessel disease. **Conclusion:** Funduscopy and TCD can be complementary tools in evaluating stroke risk in hypertensive patients.

Keywords: Funduscopy, Hypertensive retinopathy, Ophthalmic artery, Pulsatility index, Transcranial doppler

Highlights
- Hypertensive retinopathy may predict stroke risk
- TCD may complement Funduscopy in stroke with HR

Introduction

Hypertension is a prevalent modifiable risk factor for target organ damage, including the brain, kidneys, heart, and eyes. The epidemiology of hypertensive retinopathy (HR) is difficult to establish because retinal vascular changes are often obscured by the presence of other retinal vascular diseases, such as diabetes. The prevalence of hypertensive retinopathy ranges from 15% to 66%.[1] The severity and duration of hypertension were associated with a higher incidence of HR.[1] Epidemiological data on HR in Indonesia remain limited; however, several studies have provided relevant data. For instance, a study conducted at a tertiary hospital in West Sumatra documented a prevalence rate of 46.5%.[2] Another study from a hospital in Jambi, Indonesia, found that HR was more common among male patients, predominantly within the 51–60-year age group, and most had a duration of hypertension of less than five years.[3]

Among ocular manifestations, HR is the most common and has been associated with increased stroke risk.[4,5] According to the American Heart Association/American Stroke Association, stroke is defined as an acute neurological deficit syndrome due to injury to the brain, spinal cord, or retina, explainable by a vascular etiology.[6] Based on data from the Indonesian Ministry of Health in

2023, the prevalence of stroke in Indonesia reached 8.3 per 1,000 population.[7] Although there is speculation about a possible relationship between HR and stroke, research on this topic remains limited. HR can predict the long-term risk of stroke, regardless of blood pressure levels, even in hypertensive patients with well-controlled blood pressure.[8-10] Therefore, retinopathy should be included in the routine screening of hypertensive patients.[11]

Retinal funduscopy serves as a non-invasive method for detecting hypertension-mediated organ damage, comparable to microalbuminuria and electrocardiography. Funduscopic evaluation for the diagnosis of HR may demonstrate characteristic features, including generalized arteriolar narrowing, increased arteriolar wall reflex (copper wiring), arteriovenous nicking, retinal hemorrhages (flame-shaped hemorrhages), cotton wool spots, and optic disc swelling (papilledema).[1]

In stroke evaluation, various imaging modalities are used to assess cerebral hemodynamics, including cerebral digital subtraction angiography, carotid Doppler ultrasound, transcranial color-coded duplex sonography and transcranial Doppler (TCD) ultrasonography.[12,13] Among these, Color Doppler Transcranial Doppler offers a non-invasive, repeatable, and portable method for assessing intracranial blood flow dynamics. Through specific cranial acoustic windows, TCD can evaluate flow in major cerebral arteries, including the ophthalmic artery via the transorbital approach. TCD provides accurate information on vascular conditions such as occlusion, reperfusion, stenosis, and vasospasm, all of which are relevant in the context of stroke.[14,15] Hemodynamic changes in the cerebral blood vessels observed in stroke patients with HR through funduscopy and ophthalmic artery TCD are expected to provide supportive information for controlling hypertension as a risk factor for stroke.

Objective

This study utilizes funduscopic evaluation and ophthalmic artery hemodynamic assessment to investigate the vascular profiles of ischemic stroke patients with HR at a tertiary referral hospital in Indonesia.

Method

This descriptive cross-sectional study with retrospective data collection, conducted at the Neurology Department, Cipto Mangunkusumo National Hospital. Data were collected from May 2022 to May 2025 using secondary data from medical records of patients treated at the Neurology (Neuro-Ophthalmology and Neuro-Otology) Clinic. Inclusion criteria were ischemic stroke patients aged ≥17 years diagnosed with HR who underwent ophthalmic artery TCD. Exclusion criteria included incomplete medical records. Patient data were retrieved from electronic medical records, including age, sex, smoking status, hypertension duration, diabetes mellitus status, funduscopic classification (Wong & Mitchell), and ophthalmic artery Pulsatility Index (PI) from TCD.

The data were analyzed using descriptive statistical methods with SPSS software. Demographic characteristics, independent variables, and dependent variables were summarized using univariate analysis. Categorical variables were presented as frequencies and percentages, whereas numerical variables were assessed for normality using the Kolmogorov–Smirnov test. Normally distributed variables were presented as mean ± standard deviation, while non-normally distributed variables were reported as median with minimum–maximum values.

Ethical clearance for this study was obtained from the ethics committee of the Faculty of Medicine, Universitas Indonesia, ensuring adherence to all relevant ethical standards and guidelines during the data collection and analysis process.

Result

Demographic Data

A total of 74 stroke patients with HR were initially identified for this study. Seven patients were excluded due to incomplete data, resulting in 67 eligible patients analyzed in the study. Of these, 61% were male, and 39% were female. As shown in Figure 1, most patients (46%) were aged 45–59 years. Ten patients (15%) were aged 25–44 years, and three patients were over 75 years, based on WHO age classification.

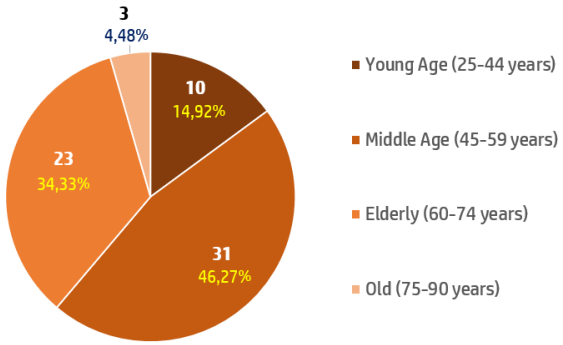

Figure 1. Percentage Distribution of Age in Stroke Patients with HR

Risk Factors

Regarding risk factors for stroke patients with HR, aside from the duration of hypertension, the presence of diabetes mellitus and smoking status were also assessed. A total of 37 patients (55%) were smokers, while 30 patients (45%) were non-smokers. Among the participants, 27 patients (40%) were diagnosed with

diabetes mellitus, while the remaining 40 patients (60%) were not. Figure 2 indicates that, the duration of hypertension among stroke patients with HR was less than one year in 15 cases, 1–5 years in 25 cases, 5–10 years in 13 cases, and more than 10 years in 14 cases. Based on the Wong and Mitchell classification, 58 patients (87%) presented with mild HR, while 9 patients (13%) had moderate disease. No severe cases were recorded, likely because the study participants were outpatients in relatively good general health who attended the clinic for routine follow-up.

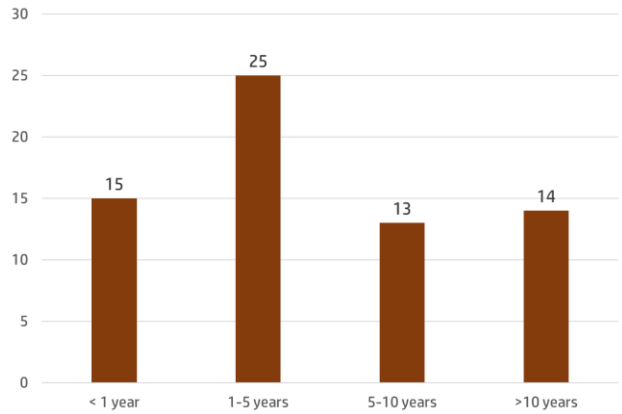

Figure 2. Percentage distribution of hypertension duration in patients with stroke and HR

TCD Profile of the Ophthalmic Artery in Stroke Patients with HR

Table 1 shows the statistical analysis of the mean difference test in this study, indicating a mean PI value of 1.28, exceeding the normal reference range of 0.5–1.0 cm/s for the ophthalmic artery reported in prior studies.

Table 1. The distribution of values for PSV, EDV, MFV, and PI of the right and left eyes based on TCD examination in Stroke Patients with HR

Variable	Right Eye	Left Eye
PSV	39.77 ± 11.69	37.65 (17.00-73.50)
EDV	11.30 (6.00-21.20)	11.30 (6.80-26.80)
MFV	20.30 (10.00-40.70)	20.08 (11.00-39.90)
PI	1.28 ± 0.24	1.24 ± 0.29

Presented either as mean±SD or median (range)
EDV: End Diastolic Velocity, MFV, Mean Flow Velocity, PI, Pulsatility Index, PSV, Peak Systolic Velocity

A PI < 1.1 was found in 23 patients, with 8 cases involving both eyes and 15 patients affecting only one eye. Further information is needed regarding the use of antihypertensive medications and lifestyle factors such as diet and exercise, which influence blood pressure control. This is important to determine whether patients with normal PI values achieved them due to optimal hypertension management through consistent lifestyle modification and/or regular medication use, rather than only from the duration of hypertension.

Discussion

This study enrolled 67 stroke patients with HR who underwent Neuro-Ophthalmology–Neuro-Otology and TCD assessments at Cipto Mangunkusumo National Hospital. Male patients predominated (61%), with most being middle-aged (45–59 years) or elderly (60–74 years). Among young stroke patients, 9 were female and 1 was male, reflecting the lower stroke risk in premenopausal women.[16,17] Unfortunately, data on hormonal contraceptive use were not available in the medical records.[18]

In addition to hypertension duration, diabetes mellitus and smoking were evaluated. Smoking was reported in 53% of patients, and 40% had diabetes. Among the 10 patients with moderate HR, 4 had a history of smoking. These findings suggest no direct association between smoking and the severity of HR in this cohort, although some previous studies have reported such a relationship.[17] This finding may reflect the study's limitations, as the sample was drawn from outpatient clinics and likely did not include severe cases of HR, which are more commonly observed in hospitalized patients during hypertensive crises. Furthermore, A more detailed history of daily cigarette consumption and cigarette type is needed to clarify the relationship between smoking and the severity of HR in stroke patients.[19]

TCD examination revealed a mean PI of more than 1.2, reflecting the presence of atherosclerotic processes in the ophthalmic artery in both mild and moderate HR. These findings align with previous study indicating that elevated PI reflects increased distal vascular resistance due to factors such as intracranial pressure elevation, distal vascular stenosis or occlusion, aging, or small-vessel disease.[20-22] These modalities may complement each other and potentially contribute to stroke prevention, particularly through the management of hypertension as a risk factor.[23-27]

Additional data on antihypertensive therapy and lifestyle modifications such as diet and exercise are needed to determine whether normal PI values reflect effective blood pressure control rather than merely the duration of hypertension.[20]

This study's single-center, retrospective, cross-sectional design limits the ability to establish causal relationships between HR, stroke severity, and ophthalmic artery hemodynamics, and may underrepresent patients with severe HR. Key clinical data, including medications, lifestyle factors, reproductive history, and detailed smoking exposure, were unavailable, and the modest sample size (n=67) reduces generalizability. Future research should focus on prospective, multicenter, longitudinal studies with larger cohorts, comprehensive risk factor evaluation, comparison groups, functional outcomes, long-term

follow-up, and advanced imaging to better assess the predictive value of HR and ophthalmic artery PI in stroke.

Conclusion

TCD evaluation in stroke patients with HR revealed a mean PI exceeding 1.2, suggesting atherosclerotic changes in the ophthalmic artery in both mild and moderate cases. Most patients in this study presented with mild funduscopic changes accompanied by elevated ophthalmic artery PI, indicating potential microvascular pathology. Funduscopy and TCD may serve as complementary tools for evaluating stroke risk in patients with HR. Further studies are warranted to clarify the relationship between HR and stroke and to provide additional insights for stroke prevention through optimal hypertension management.

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None.

Conflict of Interest
The authors declared no conflict of interest.

Ethic consideration
Approved by the Ethics Committee with protocol number KET-641 /UN2.FI/ETIK/PPM.00.02/2025, Faculty of Medicine, Universitas Indonesia.

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Author contribution
Dini Adriani: Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing-Original Draft, Writing-Review and Editing, Visualization, Supervision. **Eva Dewati:** Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing-Original Draft, Writing-Review and Editing. **Freddy Sitorus:** Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing-Original Draft, Writing-Review and Editing. **Ni Nengah Rida Ariani:** Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing-Original Draft, Writing-Review and Editing, Supervision. **Dinda Diafiri:** Conceptualization, Methodology, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing-Original Draft, Writing-Review and Editing, Supervision. **Tiara Kasih:** Conceptualization, Validation, Writing-Original Draft, Writing-Review and Editing, Visualization, and Software. **Mohammad Kurniawan:** Conceptualization, Methodology, Validation, Writing-Original Draft, Writing-Review and Editing, Visualization, Supervision, and Project Administration.

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