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Abstract

Background and objectives: Hypertension causes damage to various organs such as the kidneys and eyes. The effects of hypertension on the eyes are often found in patients with retinopathy which can be measured by Fundoscopy. The effects of hypertension on the kidneys can cause renal vascular resistance which can be measured by the Renal Resistive Index (RRI). This study aims to determine the relationship between RRI values and the incidence of retinopathy in hypertensive patients.

Method: This study is an analytical observational study with a cross-sectional design by examining RRI and Fundoscopy values in patients who have been diagnosed with hypertension at Dr. Wahidin Sudirohusodo Hospital and Hasanuddin University Teaching Hospital from June 2024 to November 2024. RRI measurements using Intrarenal Artery Doppler USG and retinopathy screening using fundoscopy. Data were analyzed using the chi-square test, Spearman correlation and independent sample t test.

Results:A total of 56 hypertension patients were successfully collected, most of whom were aged < 60 years (69.6%) and female (53.6%). RRI has a significant relationship with retinopathy ($p < 0.001$). There is a positive correlation between RRI value and Retinopathy Incidence ($r = 0.923$; $p < 0.001$). RRI ≥ 0.7 was found to be significantly higher in retinopathy patients (100%) compared to non-retinopathy (0%) ($p < 0.05$).

Conclusion: There is a correlation between increasing RRI values and the incidence

of retinopathy in hypertensive patients.

Keywords: hypertension, retinopathy, renal resistive index

INTRODUCTION

Hypertension is one of the diseases that causes high morbidity and mortality rates worldwide. In 2010, it was reported that around 1.39 billion people in the world were diagnosed with hypertension, of which 349 million came from high-income countries and 1.04 billion came from low-middle-income countries [1]. Data from 2016 showed that hypertension was the cause of death globally in 10.4 million patients per year [2] In Indonesia, based on the 2018 Basic Health Research (Riskesdas), the prevalence of hypertension reached 34.1%, this data increased when compared to the prevalence of hypertension in 2013 which was 25.8% [3].

Hypertension affects almost every organ in the body at both the micro and macrovascular levels. There are many specific organ changes caused by hypertension that lead to Hypertension-Mediated Organ Damage (HMOD). HMOD is a structural or functional change in the arterial blood vessels and/or the organs they supply due to increased blood pressure. The damage referred to includes the brain, central and peripheral arteries, eyes, heart and kidneys [4,5].

Changes in the retinal blood vessels associated with hypertension can be seen directly by the physician during an ophthalmologic examination and are assessed as hypertensive retinopathy. The pathogenesis of hypertensive retinopathy is believed to consist of complex, interrelated phases, rather than developing through sequential steps. These phases are defined as the vasoconstrictive, exudative, and sclerotic phases. In addition to causing eye problems, essential hypertension can periodically cause impaired renal function. This is because renal blood flow depends on the interaction between systemic blood pressure and renal vascular resistance. A test that can evaluate renal vascular resistance is the Renal Resistive Index (RRI) [6-8].

Renal resistive index is a non-invasive parameter to assess blood vessel resistance measured using Doppler ultrasonography [9]. In adults, an RRI value <0.70 is considered normal [10]. Increased RRI is associated with a more rapid decline in kidney function, even when the glomerular filtration rate is still within normal limits. In addition, in hypertensive patients, RRI is also associated with changes in extrarenal organs such as Retinopathy [8,10].

Several studies have shown an association between RRI and hypertensive retinopathy, hypertensive nephrosclerosis, hypertension-related cerebrovascular changes, and left ventricular hypertrophy are the main end-organ injuries associated with hypertension. The risk of stroke in patients with retinopathy is a frequently studied topic due to the close relationship between retinal and cerebral vascularization. It has previously been shown in a study that the presence of hypertensive retinopathy is associated with an increased risk of stroke, and the risk of stroke increases with increasing degrees of retinopathy. [11]

In another study, where hypertensive retinopathy was divided into severe and mild, it was shown that the risk of hemorrhagic stroke correlated with the severity of retinopathy.[12] Considering the study examining the relationship between hypertensive retinopathy and coronary artery disease, Duncan et al.'s study of middle-aged male patients revealed that retinal microvascular changes caused a 2.1-fold increase in the risk of coronary artery disease and related events. high-risk patient group versus low-risk patient group. [13] Understanding target organ damage can help in determining the risk of retinopathy in hypertensive patients. In addition, research on the agreement between RRI values and retinopathy events in hypertensive patients in Indonesia has never been conducted before. This study aims to determine the relationship between RRI values and retinopathy in hypertensive patients.

MATERIALS AND METHODS

Patient Population

The population of this study was all patients diagnosed with hypertension at the Kidney Hypertension Polyclinic of Dr. Wahidin Sudirohusodo General Hospital and Hasanuddin University Teaching Hospital from June 2024 to November 2024. The study sample was patients who met the inclusion criteria.

Inclusion and exclusion criteria

Inclusion criteria were adult patients diagnosed with hypertension aged 18-65 years and willing to participate in the study. Post-kidney transplant patients either as donors or recipients, secondary hypertension and chronic kidney disease were excluded.

Clinical data and sample collection

Sampling was done by consecutive sampling. RRI measurement using Intrarenal Artery Doppler USG. The RRI cut-off value is 0.7. Retinopathy screening using fundoscopy or fundus photography. RRI and Fundoscopy measurements are carried out by 1 operator.

statistical analysis

Data were analyzed using SPSS version 26. The analysis approach used statistical tests and descriptive approaches. The purpose of the cross-sectional design approach was to collect general details about the research sample. Mean values, standard deviations (SD), and frequency distributions were calculated using statistical methods. Chi-square test, Spearman correlation, and independent sample t-test were used. If the p-value of the test is less than 0.05, the statistical test findings are considered significant. Complete with tables and figures, the collected results will be presented narratively.

RESULTS

Study Population

This study collected 56 hypertensive patients consisting of 26 male subjects (46.4%) and 30 female subjects (53.6%) aged between 29-86 years, with an average age in this study of <60 years as many as 39 subjects (69.6%), and >60 years as many as 17 subjects (30.4%). Of the 56 hypertensive subjects, controlled hypertension was found in 38 subjects (67.9%), while uncontrolled hypertension was found in 18 subjects (32.1%). Findings of retinopathy in subjects in this study were found in 20 subjects (35.7%) while the other 36 subjects (64.3%) did not find retinopathy.

The results showed that there was a significant positive correlation between RRI values and Retinopathy ($p<0.001$), where the higher the RRI value, the higher the risk of retinopathy. Based on the correlation coefficient (R) value, the closeness of the relationship between RRI and Retinopathy is included in the high category ($R<0.932$). This means that the higher the RRI value, the higher the risk of retinopathy in patients.

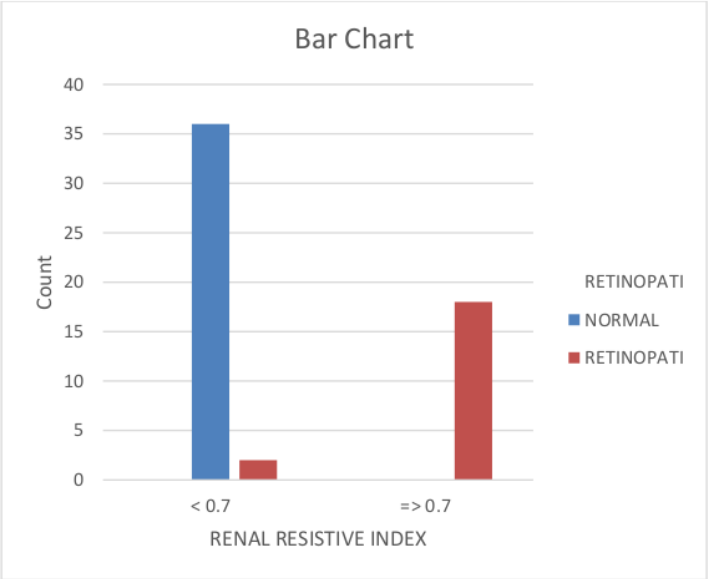

Figure 1. Correlation of RRI with Retinopathy

RRI (Renal Resistive Index), Retinopathy

In this study, a significant relationship was found between RRI and retinopathy ($p<0.001$) as seen in Table 1 where the incidence of Retinopathy was found to be significantly higher in RRI ≥ 0.7 compared to RRI <0.7. This means that Retinopathy has a significant relationship with RRI.

Table 1. Relationship between Renal Restrictive Index and Retinopathy

Variables	RRI	n	SD	p
Retinopathy	≥ 0.7	18	0.01	<0.001
	< 0.7	2	0.04	

RRI (Renal Resistive Index), Retinopathy

The proportion of uncontrolled hypertension patients was found to be higher in patients with retinopathy (90%) compared to those without retinopathy (10%), as can be seen in Table 2 where RRI ≥ 0.7 was found to be significantly higher in patients with retinopathy (100%) compared to patients without retinopathy (0%).

Table 2. Comparison of Renal Restrictive Index and Retinopathy values

RRI		Retinopathy		Amount	p
		Retinopathy	No Retinopathy		
≥ 0.7	n	18	0	18	<0.001
	%	100%	0.0%	100.0%	
< 0.7	n	2	36	38	
	%	5.2%	94.8%	100.0%	
Amount	n	20	36	56	
	%	35.7%	64.3%	100.0%	

RRI (Renal Resistive Index), Retinopathy

DISCUSSION

The results of this study indicate that there is a positive relationship between RRI and Retinopathy, where the correlation coefficient value (r) obtained is 0.923 (Figure 1), a significant positive correlation was obtained between RRI and Retinopathy (p <0.001). This finding is in accordance with previous research by Ozen et al. [6] who conducted a study on 60 hypertensive patients found that there was a positive correlation between RRI and Retinopathy (r = 0.83, P <0.001). Similar results in Basturk et al. [14] who conducted a univariate analysis on 103 hypertensive patients with diabetes mellitus where RRI was found to be significantly correlated with Retinopathy (r = 0.47, P <0.01)

This indicates that the higher the vascular resistance in the kidneys reflected by the increased RRI value, the greater the increase in retinal vascular resistance. In addition, diabetes mellitus is also a factor that aggravates the occurrence of retinopathy. Diabetic retinopathy and nephropathy often go hand in hand, patients with type 2 diabetes who come with diabetic retinopathy are likely to also experience diabetic nephropathy and the absence of retinopathy in diabetic patients is often associated with a better kidney prognosis.[14]

In this study, a comparison was obtained between groups with RRI ≥ 0.7 and RRI <0.7, it was found that the RRI ≥ 0.7 group had a significantly higher risk of retinopathy compared to the RRI <0.7 group (p <0.001) (Table 1). This is in line with Ozen et al [6] who conducted a study on 60 hypertensive patients and separated patients with RRI <0.7 (18 patients) and ≥ 0.7 (42 patients) obtained results that patients with RRI ≥ 0.7 experienced retinopathy with a significant number (P <0.001). Basturk et al [14] conducted a study on 103 patients with hypertension and diabetes mellitus found that RRI values were associated with Retinopathy (P <0.01).

Diabetes is a strong risk factor for arteriosclerosis in the elderly, this can apply to all types of arterial blood vessels. In diabetic retinopathy, the orbital artery velocity decreases due to fibrosis and atherosclerosis processes in the orbital blood vessel structure. So this results in hemodynamic disorders in the eye and causes damage to the retinal structure.[14]

Overall, the results of this study indicate that RRI has a significant relationship with Retinopathy. This finding underlines the importance of evaluating RRI as a parameter in detecting structural changes in the retina, especially in the context of hypertension. The strength of this study is that this is the first study to analyze the correlation between RRI and Retinopathy in hypertensive patients. The limitations of this study are that it did not assess blood pressure control, duration of hypertension and type of hypertension medication and used a small sample size.

CONCLUSION

The increase in RRI values corresponds to the increase in the incidence of retinopathy in hypertensive patients. These results imply that it is necessary to evaluate RRI as a parameter in detecting retinal damage, especially in the context of hypertension.

Conflict of interest:

Each author declares that they have no financial relationships (such as stock ownership, equity ownership, consultancies, patent/licensing arrangements, etc.) that might create a conflict of interest with respect to the submitted work.

Ethics Committee Approval:

The Human Biomedical Research Ethics Committee at the Faculty of Medicine, Hasanuddin University in Makassar, South Sulawesi, Indonesia, approved this study. Based on the recommendation letter number 784/UN4.6.4.5.31/PP36/2024, dated September 27, 2024

Author's contributions:

DNN (Concept, Design, Materials, Sources, Data Processing, Interpretation and Analysis, Literature Search, and Manuscript Editing). NM (Concept, Planning, Guidance, Interpretation and Analysis). AMI (Concept, Planning, Guidance, Evaluation, and Knowledge Search of the Literature). SB (Concept, Planning, Guidance, Evaluation, and Knowledge Search of the Literature). AMLP (Concept, Planning, Guidance, Evaluation, and Knowledge Search of the Literature). HR (Concept, Planning, Guidance, Evaluation, and Knowledge Search of the Literature). HK (Concept, Planning, Guidance, Evaluation, and Knowledge Search of the Literature). AA (Concept, Design, Critical Review). KKH (Concept, Design, Critical Review). AF (Concept, Design, Critical Review) and AAZ (Concept, Planning, Guidance, Evaluation, and Knowledge Search of the Literature).

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REFERENCES

1. Unger, T., Borghi, C., Charchar, F., Khan, N.A., Poulter, N.R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G.S., & Tomaszewski, M. (2020) . 2020 International Society of Hypertension global hypertension practice guidelines. Hypertension, 75(6), 1334–1357.
2. Mills, K.T., Bundy, J.D., Kelly, T.N., Reed, J.E., Kearney, P.M., Reynolds, K., Chen, J., & He, J. (2016). Global Disparities of Hypertension Prevalence and Control: A Systematic Analysis of Population-Based Studies From 90 Countries. Circulation, 134(6), 441–450.
3. Stanaway, JD, Afshin, A., Gakidou, E., Lim, SS, Abate, D., Abate, KH, Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela , J., Abdelalim, A., Abdollahpour, I., Abdulkader, RS, Abebe, M., Abebe, Z., Abera, SF, Abil, O.Z., Abraha, H.N., … Murray, C.J.L. (2018). Global, regional, and national comparative risk assessment of 84 behavioral, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: A systematic analysis for the Global Burden of Disease Study 2017. The Lancet, 392 (10159), 1923–1994.
4. Ministry of Health of the Republic of Indonesia. (2019). National Report of Riskesdas 2018. Health Research and Development Agency.
5. Nadar, SK, & Lip, GYH (2021). The heart in hypertension. J Hum Hypertens, 35(5), 383–386.
6. Karagöz Özen, DS, Aydın, MM, Genç, İ., & Demirağ, MD (2023). The relationship between renal resistive index and hypertensive end-organ damage. Journal of Surgery and Medicine, 7(1), 86–90.https://doi.org/10.28982/josam.7627
7. Tan, W., Yao, X., Le, T.T., Tan, B., Schmetterer, L., & Chua, J. (2022). The New Era of Retinal Imaging in Hypertensive Patients. In Asia-Pacific Journal of Ophthalmology (Vol. 11, Issue 2, pp. 149–159). Lippincott Williams and Wilkins. https://doi.org/10.1097/APO.0000000000000509
8. Sveceny, J., Charvat, J., Hrach, K., Horackova, M., & Schuck, O. (2022). In essential hypertension, a change in the renal resistive index is associated with a change in the ratio of 24-hour diastolic to systolic blood pressure. Physiological Research, 341–348
9. Andrikou, I., Tsioufis, C., Konstantinidis, D., Kasiakogias, A., Dimitriadis, K., Leontsinis, I., Andrikou, E., Sanidas, E., Kallikazaros, I., & Tousoulis, D. (2018). Renal resistive index in hypertensive patients. J Clin Hypertens, 20(12), 1739–1744.
10. Granata, A., Zanoli, L., Clementi, S., Fatuzzo, P., Di Nicolò, P., & Fiorini, F. (2014). Resistive intrarenal index: Myth or reality? Brit. J. Radiol, 87(1038), 20140004.

11. Chen X, Liu L, Liu M, Huang X, Meng Y, She H, et al. Hypertensive Retinopathy and the Risk of Stroke Among Hypertensive Adults in China. Invest Ophthalmol Vis Sci. 2021 Jul 1;62(9):28. doi: 10.1167/iovs.62.9.28. PMID: 34283210; PMCID: PMC8300046.
12. Thiagarajah R, Kandasamy R, Sellamuthu P. Hypertensive Retinopathy and the Risk of Hemorrhagic Stroke. J Korean Neurosurg Soc. 2021 Jul;64(4):543-51. doi: 10.3340/jkns.2020.0285. Epub 2021 Jul 1. PMID: 34237912; PMCID: PMC8273771.
13. Duncan BB, Wong TY, Tyroler HA, Davis CE, Fuchs FD. Hypertensive retinopathy and incidence of coronary heart disease in high risk men. Br J Ophthalmol. 2002 Sep;86(9):1002-6. doi: 10.1136/bjo.86.9.1002. PMID: 12185127; PMCID: PMC1771277.
14. Basturk, T., Akcay M., Albayrak, R., Unsal, A., Ulas, T., (2012). Correlation between the Resistive Index Value of Renal and Orbital Arteries. Kidney Blood Press Res., 35 : 332-339.