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EFFECT OF DIABETIC RETINOPATHY PROGRESSION ON VISUAL ACUITY IN TYPE II DM PATIENTS

Rajendra Ekki Maulana¹, Ramzi Amin², Syarif Husin³

¹Program Studi Pendidikan Dokter, Fakultas Kedokteran, Universitas Sriwijaya, Palembang, Indonesia
 ²Departemen Ilmu Kesehatan Mata, Divisi Vitreoretina, Fakultas Kedokteran, Universitas Sriwijaya, Palembang
 ³Departemen Gizi, Fakultas Kedokteran, Universitas Sriwijaya, Palembang, Indonesia

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Corresponding author : Ramzi Amin Departemen Ilmu Kesehatan Mata, Divisi Vitreoretina, Fakultas Kedokteran, Universitas Sriwijaya

Email: ramzi.amin26@gmail.com

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis pengaruh antara tingkat keparahan RD dengan tajam penglihatan serta mengeksplorasi faktor-faktor lain yang dapat mempengaruhi tajam penglihatan. Penelitian ini menggunakan desain analitik observasional dengan pendekatan potong lintang. Sampel terdiri atas data rekam medis pasien DM tipe II yang didiagnosis RD di RSUP Dr. Mohammad Hoesin Palembang pada periode Januari 2021 hingga Oktober 2024. Analisis data dilakukan dengan uji Fisher's exact untuk menguji tingkat signifikansi, kemudian dilanjutkan dengan analisis regresi logistik guna menentukan faktor yang paling berpengaruh dominan. Hasil penelitian didapatkan bahwa perkembangan dari RD memberikan efek signifikan dengan tajam penglihatan (p=0,008), sedangkan faktor lain yakni edema makula (p=0,137), usia (p=1,000), jenis kelamin (p=1,000), tekanan intraokular (p=1,000), kadar HbA1c (p=1,000), dan riwayat hipertensi (p=1,000) tidak berhubungan signifikan. Kesimpulan penelitian ini adalah efek dari perkembangan RD memiliki hasil signifikan dan berpengaruh secara dominan terhadap tajam penglihatan.

ABSTRACT

Effect of Diabetic Retinopathy Progression on Visual Acuity in Type II DM Patients. This study aims to assess the effect of DR severity on visual acuity and to identify additional contributing factors. An observational analytic study with a cross-sectional design was conducted using medical records of Type II DM patients diagnosed with DR at Dr. Mohammad Hoesin General Hospital, Palembang, between January 2021 and October 2024. Statistical analysis was performed using Fisher's exact test to evaluate significance, followed by logistic regression to determine the most influential factor. The results showed a significant association between DR severity and visual acuity (p=0.008), while other factors including macular edema (p=0.137), age (p=1.000), gender (p=1.000), intraocular pressure (p=1.000), HbA1c levels (p=1.000), and history of hypertension (p=1.000), were not significantly associated. In conclusion DR severity has a significant and dominant influence on the visual acuity of DR patients.

INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic syndrome characterized by hyperglycemia and ranks among the top ten causes of death globally.^{1,2} Persistent hyperglycemia leads to macrovascular and microvascular complications, with Diabetic Retinopathy (DR) being a leading cause of visual morbidity and disability among DM patients.^{3,4}



DR results from damage to the retinal microvasculature. It accounts for 4.8% of the 39 million cases of blindness worldwide. Prevalence in developing countries varies between 19% in Bangladesh, 17–22% in India, 30.3% in rural China, and 63% in South Africa. Similar rates are observed in developed nations such as Australia, the UK, and the USA. In Indonesia, studies show a 50.7% prevalence in Padang, making it the second most common DM complication after nephropathy.^{5,6}

DR is progressive and can lead to irreversible blindness if not properly managed. It is classified into Non-Proliferative Diabetic Retinopathy (NPDR) and Proliferative Diabetic Retinopathy (PDR), with severity categorized into mild, moderate, severe NPDR, and PDR according to the International Clinical Diabetic Retinopathy (ICDR) severity scale.⁷⁻⁹

As DR severity increases, so does the risk of vision loss. Other factors, such as poor glycemic control, hypertension, and macular edema, can further impair visual acuity.^{10,11} While previous studies have examined the relationship between DR severity and visual acuity, their results have varied.¹²⁻¹⁴ This study aims to analyze the association between DR severity and visual acuity in Type II DM patients at Dr. Mohammad Hoesin Hospital.

METHODS

This observational analytic study used a cross-sectional design. Data were retrospectively collected from the medical records of Type II DM patients diagnosed with DR from January 2021 to October 2024 at Dr. Mohammad Hoesin General Hospital.

Using purposive sampling, 62 patients (124 eyes) met the inclusion criteria. Minimum sample size calculation was based on previous studies.¹⁵

Independent variables included age, gender, DR severity, intraocular pressure, HbA1c level, history of hypertension, and presence of macular edema. The dependent variable was visual acuity, categorized according to WHO criteria.

The inclusion criteria for this study were medical records of patients with type II DM diagnosed with diabetic retinopathy who had complete data on sociodemographic characteristics, severity of RD (right and left eyes), visual acuity (right and left eyes), intraocular pressure (right and left eyes), HbA1c levels, history of hypertension, and involvement of macular edema (right and left eyes). Subjects were excluded if the medical records obtained were incomplete or damaged.

The severity categories of RD used in this study were Proliferative Diabetic Retinopathy (PDR) and Non-Proliferative Diabetic Retinopathy (NPDR). Visual acuity was classified based on WHO criteria where normal vision was characterized by vision <6/12, while visual impairment was characterized by vision $\geq 6/12$. HbA1c levels were grouped into uncontrolled ($\geq 7\%$) and controlled (<7%). Intraocular pressure was grouped into high (>21mmHg) and normal (10-21mmHg). The involvement of macular edema referred to in this study is the presence or absence of edema in the retina in the macular area based on the results of the funduscopy examination that have been listed in the medical record data. Data analysis utilized SPSS version 27.0, applying univariate, bivariate (Chi-Square or Fisher's exact test), and multivariate (logistic regression) analyses. A p-value <0.05 was considered statistically significant with confidence interval 95%.

RESULTS

Descriptive analysis showed most subjects were female, aged ≥60 years, with uncontrolled HbA1c levels, and had a history of hypertension. Among the eyes analyzed, 73 (58.9%) had PDR, and 116 eyes (93.5%) exhibited visual impairment.

Variables		n	%
(n = 62 subjects)			
Age	≥60 years	44	71
	<60 years	18	29
Gender	Female	38	61,3
	Male	24	38,7
HbA1c levels	Uncontrolled	49	79
	controlled	13	21
History of hypertension	Yes	43	69,4
	No	19	30,6
(n = 124 eyes)			
Severity	PDR	73	58,9
	NPDR	51	41,1
Visual acuity	Visual impairment	116	93,5
	Normal	8	6,5
Intraocular pressure	Increased	14	11,3
	Normal	110	88,7
Macular edema	Yes	70	56,5
	No	54	43,5

Table 1. Characteristics of research subjects

Fisher's exact test showed a significant association between DR severity and visual acuity (p=0.008). Other factors such as macular edema (p=0.137), age (p=1.000), gender (p=1.000), intraocular pressure (p=1.000), HbA1c (p=1.000), and hypertension (p=1.000) were not significantly associated.

		Visual acuity						
Variable		Visual impairment		Normal		p-value	OR	95% CI
		<u> </u>		n %				
(n = 62 patients)								
Age	≥60 years	18	100	0	0	1,000	-	-
	<60 years	43	98,4	1	1,6			
Gender	Female	37	97,4	1	2,6	1,000	-	-
	Male	24	100	0	0			
HbA1c levels	Uncontrolled	48	98	1	2	1,000	-	-
	controlled	13	100	0	0			
History of hypertension	Yes	48	98	1	2	1,000	-	-
	No	13	100	0	0			
(n = 124 eyes)								
Severity	PDR	72	98,6	1	1,4	0,008	11,455	1,363-
	NPDR	44	86,3	7	13,7			96,253
		13	92,9	1	7,1	1,000	0,0883	

Table 2. Association between the variables studied and visual acuity

Visual acuity	Visual impairment	103	93,6	7	6,4			0,101- 7.763
	Normal	67	97,1	2	2,9	0 1 2 7	4 102	0,794-
Intraocular pressure	Increased	49	89,1	6	19,9	0,137	4,102	21,193

In the regression test, the unit of analysis used was the eye, with the dependent variable being visual acuity. Although both eyes came from the same patient, the right and left eyes had different clinical characteristics, so each eye could be considered an independent unit.

Table 3 shows the results of the logistic regression test. The results of the first stage analysis showed that the severity of RD (p=0.018) and macular edema (p=0.036) were statistically significant variables in influencing visual acuity. Other variables such as age (p=0.972), gender (p=0.350), intraocular pressure (p=0.914), HbA1c levels (p=0.159), and history of hypertension (p=0.637) were not statistically significant, indicating that these variables did not provide a strong enough independent contribution to visual acuity in the initial model.

	Variable	В	p value	95% CI for B
Stages 1	Age	0,031	0,972	0,173-6,139
	Gender	0,767	0,350	0,431-10,752
	HbA1c levels	-1,731	0,159	0,016-1,965
	History of hypertension	-0,454	0,637	0,096-4,184
	Severity	2,720	0,018	1,587-145,075
	Intraocular pressure	-0,139	0,914	0,070-10,889
	Macular edema	1,962	0,036	1,142-44,289
Stages 6	Severity	2,534	0,021	1,469-108,206
	Macular edema	1,549	0,072	0,869-25,521

Table 3. Results of multivariate analysis with logistic regression test

The backward elimination process produced the final model in the sixth step, with only two variables remaining, namely severity (p = 0.021) and macular edema (p = 0.072). The results of this multivariate analysis indicate that the most dominant factor influencing visual acuity in RD patients is severity. Macular edema became insignificant in the final model (p = 0.072), indicating that the effect of macular edema was mediated by the severity itself. In this study, it was found that there was no significant relationship between age and visual acuity (p = 1.000).

The results of this study are inconsistent with several previous literatures which state that visual acuity tends to deteriorate with age due to a gradual decrease in the ability of retinal cell regeneration.^{17–19} In addition, in older patients, microvascular disorders due to diabetes have a cumulative damage effect on the retina which indirectly affects visual acuity.²⁰ This indicates that the age factor needs to be analyzed further with a larger sample to provide a more accurate.

DISCUSSION

The development of RD disease, in this study was found to have a significant effect on visual acuity (p = 0.008). These findings are in line with previous studies that found that the severity of RD significantly affects the prognosis of visual acuity, especially when combined with poor glycemic control.^{21,22} Decreased visual acuity in RD patients is mainly caused by complications such as Diabetic Macular Edema (EMD) and Diabetic Macular Ischemia (DMI). DMI causes functional retinal disorders, including damage to the foveal structure. On the other hand, DME is the main cause of

moderate to severe visual impairment in patients with RD which tends to occur at worse RD severity.^{23,24} In addition, the role of neovascularization in PDR can contribute to blindness, especially through complications such as vitreous hemorrhage, retinal traction, and retinal detachment. New blood vessels that are fragile and abnormal increase the risk of intraocular hemorrhage which can permanently impair vision.²⁵

Meanwhile, macular edema, in this study was found in the majority of subjects' eyes. The results of the analysis showed that the relationship between macular edema and visual acuity was not statistically significant (p = 0.137). The findings in this study differ from previous studies which stated that DME is one of the main causes of visual impairment in RD patients. DME occurs due to fluid accumulation in the macular area which can interfere with the photoreceptor segment and optic pathway in the retina. This can directly affect the patient's visual acuity.^{26,27}

In addition, the results of the study also showed that RD patients who did not experience DME mostly still experienced visual impairment. This can be based on another mechanism, namely DMI, which is characterized by an enlargement of the foveal avascular zone due to retinal microvascular occlusion. DMI can occur independently or simultaneously with DME. The severity of DMI is associated with worse visual impairment, even in patients without macular edema.^{28,29}

Based on intraocular pressure, it was found that intraocular pressure was not significantly related to visual acuity (p = 1,000). RD patients with high intraocular pressure are generally associated with complications such as neovascular glaucoma.²⁰ However, in the context of RD patients without complications, the effect of intraocular pressure on visual acuity tends to be minimal. Other factors such as glycemic control and macular edema involvement have a greater effect on visual acuity than intraocular pressure itself.³⁰ Although the direct relationship between intraocular pressure and visual acuity is not statistically significant, monitoring intraocular pressure is still recommended to anticipate the risk of complications that can affect the patient's overall quality of vision.

Gender, in this study was found to be not significantly related to visual acuity (p = 1,000). Previous studies have shown varying results regarding the effect of gender on visual acuity in RD patients. The prevalence of RD is found to be higher in female patients than in male patients, especially in the elderly age group.^{20,31} Factors such as hormonal changes, metabolism, and comorbidities may contribute to the association.²¹ Gender variation has a greater influence on the prevalence of RD than visual acuity itself.

HbA1c levels in this study subjects were found to be not significantly associated with visual acuity (p = 1,000). The results obtained differ from previous studies showing that patients with high HbA1c tend to have more severe severity, with an increased risk of complications such as macular edema.^{32,33} However, although high HbA1c is associated with worsening RD, its effect on visual acuity is also influenced by other complications, such as vitreous hemorrhage and retinal nerve damage.³⁴ This suggests that HbA1c can indirectly affect visual acuity through RD progression. Although the direct relationship between HbA1c levels and visual acuity is not statistically significant, stable glycemic control remains a priority in preventing RD progression and supporting patient visual acuity.

Based on a history of hypertension, it was found that a history of hypertension was not significantly associated with visual acuity (p = 1,000). Previous studies have shown that hypertension can increase the risk of retinal microvascular damage, such as macular edema, vitreous hemorrhage, and ischemia, which worsens patients' visual acuity.³⁵ In addition, hypertension can cause disruption of the Blood Brain Barrier (BRB) function which contributes to fluid leakage and edema, resulting in

decreased visual acuity.^{36,37} The finding of an insignificant relationship in this variable is due to the uneven distribution of incidence. Further studies with larger samples can be conducted to explore the related relationship in more depth.

The research that has been conducted by researchers with a retrospective research design has several limitations, namely the study was only conducted in one hospital with a certain time period, so the results of the study may not be generalizable to a wider population or in different clinical settings. In addition, other variables such as the duration of DM and history of dyslipidemia that may have an effect on visual acuity cannot be analyzed due to limited data obtained from medical records.

CONCLUSION

The severity of diabetic retinopathy was shown to be a major factor influencing visual impairment in patients with type II DM, with the risk of visual impairment 11 times higher in patients with PDR compared to NPDR. Other factors such as age, gender, HbA1c levels, history of hypertension, intraocular pressure, and macular edema did not have a significant effect. Prevention, treatment, and early detection can provide better results in preventing visual impairment. These findings emphasize the importance of regular screening and early intervention, as well as integration of retinopathy management in primary health care to maintain visual function in patients with diabetes.

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