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## Purpose

Ischemia is a one of the factors associated with the development of age related macular degeneration (AMD)<sup>1</sup>. Choroidal circulation in the fovea was found to be reduced in AMD<sup>2</sup>. The purpose of this study was to examine whether there are also changes in retinal blood flow velocity in patients with AMD.

## Methods

We used the Retinal Function Imager (RFI, Optical Imaging Ltd., Rehovot, Israel), a non-invasive diagnostic approach for measuring blood flow velocity. Thirty-nine eyes of 33 AMD patients and 43 eyes of 26 healthy individuals over the age of 50 were included in this study. Exclusion criteria were: poor view of the retina, prior eye surgery except uneventful cataract extraction and high refraction error (> ± 6 diopters). All patients were scanned by the RFI with analysis of blood flow velocity of secondary and tertiary branches of arteries and veins. Differences among groups were assessed by mixed linear models controlling for the effect of the inclusion of both eyes in some cases as well as age, heart rate and blood pressure differences. Spearman correlation was used to determine associations between parameters.

Table 1 Patients characteristics<sup>1</sup>

	Healthy (N=26)	AMD (N=33)	P Value
	Mean (SD)	Mean (SD)	
Age	61 (8)	71 (11)	<0.001
Systolic BP	136 (17)	153 (26)	0.006
Diastolic BP	83 (10)	80 (12)	0.396
MAP	100 (11)	104 (14)	0.303
Heart Rate	68 (9)	71 (9)	0.261
	N (%)	N (%)	
Male Gender	15 (58)	11 (33)	0.061
Hypertension	11 (42)	18 (56)	0.291
Current Smoker	0 (0)	4 (13)	0.123

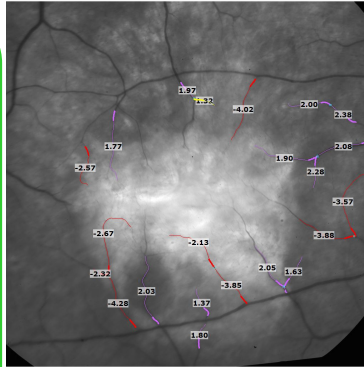


Figure 1. An example of blood flow velocity measurement by the RFI in secondary and tertiary branches of arteries (red) and veins (purple) in an AMD patient. Scale bar = 500 μ.

## Results Retinal Blood Flow Velocity Total Average Velocity

Table 2

	Healthy			AMD			P Value
	Mean (mm/sec)	Mean number of segments (SD)	95% CI	Mean (mm/sec)	Mean number of segments (SD)	95% CI	
Arterial Velocity	4.5	14 (5)	4.1 – 4.9	3.6	12 (7)	3.2 – 4.0	0.005
Venous Velocity	3.1	15 (5)	2.8 – 3.3	2.6	14 (5)	2.4 – 2.9	0.044

Table 3 Velocity by Vessel Size

	Healthy		AMD		P Value
	Mean	95% CI	Mean	95% CI	
Venous Velocity Narrow	3.0	2.7 – 3.3	2.4	2.1 – 2.7	0.010
Arterial Velocity Narrow	4.5	4.0 – 5.0	3.7	3.2 – 4.2	0.037
Venous Velocity Wide	3.3	3.0 – 3.6	2.9	2.6 – 3.2	0.089
Arterial Velocity Wide	4.6	4.1 – 5.1	3.4	2.9 – 4.0	0.004

Table 4 Velocity by AMD Type

	AMD				P Value
	Dry		Exudative		
	Mean	95% CI	Mean	95% CI	
Average V Velocity	2.4	2.0 – 2.9	2.6	2.1 – 3.1	0.643
Average A Velocity	3.4	2.6 – 4.1	3.8	3.1 – 4.6	0.438
Velocity V Narrow	2.2	1.8 – 2.6	2.4	2.0 – 2.7	0.507
Velocity A Narrow	3.4	2.3 – 4.4	4.0	3.0 – 5.0	0.423
Velocity V Wide	2.7	2.1 – 3.3	2.8	2.3 – 3.4	0.808
Velocity A Wide	3.0	2.0 – 4.0	3.8	2.8 – 4.8	0.308

## Summary

- ♦ Patient characteristics are described in Table 1.
- ♦ The average velocity in AMD patients was significantly lower compared to controls in arteries and veins (Table 2 and Figure 1).
- ♦ Subdividing the vessels segments into two groups by diameter, the velocity decrease was evident in both narrow and wide arterial groups (5-10, 10-15 μ) as well as only in the narrow veins (Table 3).
- ♦ Among the 39 AMD eyes, 23 eyes had nonexudative AMD and 16 had signs of exudative AMD. Upon comparing the velocity between these two AMD groups no significant differences in any of the retinal blood flow velocity parameters were detected (Table 4).
- ♦ In both the healthy and AMD groups, we found a significant correlation between BP parameters (systolic BP, diastolic BP and MAP) and arterial blood flow velocity (Figure 2). Venous velocity was significantly correlated with BP parameters in AMD but not in healthy controls (Figure 3). Heart rate was significantly correlated with arterial velocity in the healthy group only (Figure 4).

## Correlations of Velocity & Physiological Parameters

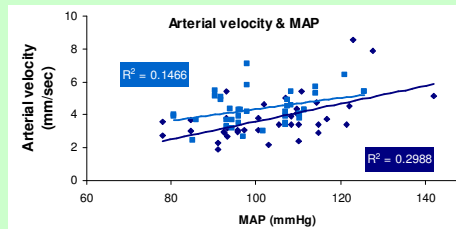


Figure 2. The correlation between retinal arterial velocity measured by the RFI (mm/sec) and mean arterial pressure (MAP; mmHg). Healthy p < 0.05; AMD p < 0.001.

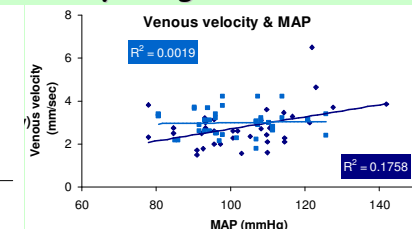


Figure 3. The correlation between retinal venous velocity measured by the RFI (mm/sec) and mean arterial pressure (MAP; mmHg). Healthy p = 0.8; AMD p < 0.01.

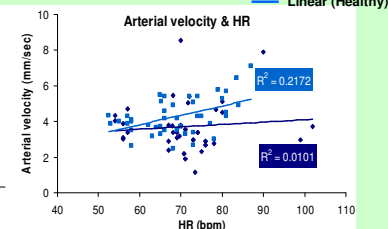


Figure 4. The correlation between retinal arterial velocity as measured by the RFI (mm/sec) and heart rate (HR; beats per minute – BPM). Healthy p < 0.01; AMD p = 0.5.

## Conclusions

We found a decrease in blood flow velocity in retinal arteries and veins in AMD patients. Despite the fact that AMD is essentially a choroidal disease, retinal vessels display functional abnormality by decreased blood velocity and abnormal hemodynamic control. These findings suggest that there is a more generalized vascular abnormality in this disease.

## References

1. Feigl B. Prog Retin Eye Res 2009;28:63-86
2. Grunwald JE, et al. Invest Ophthalmol Vis Sci 1998;39:385-390.

## Disclosures

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