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Modeling and quantifying the effect of blood pressure, intraocular pressure and blood viscosity on the central retinal artery hemodynamics in people of European and African descent

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Footnotes

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Abstract

Purpose : Pilot studies have documented differences in central retinal artery (CRA) blood flow among people of African (AD) and European descents (ED). This study uses a mathematical model to test and quantify if and to what extent the magnitude that these hemodynamic differences may be attributed to variances of intraocular pressure (IOP), systolic (SBP) and diastolic (DBP) blood pressure, and blood viscosity (BV).

Methods : Using a validated mathematical model of the retinal circulation, peak systolic velocity (PSV), end diastolic velocity (EDV), and a resistive index (RI) in the CRA were simulated based on clinically measured IOP, SBP, and DBP values (Tab. 1). The study included data from 189 glaucoma eyes (66 AD, 123 ED; PMID: 23807346) and 58 healthy eyes (24 AD, 34 ED; PMID: 27561101). The values of PSV, EDV, and RI simulated with the mathematical model based on clinical inputs were compared with the values measured via Color Doppler Imaging (CDI).

Results : Clinical studies report that PSV and EDV are higher in people of ED for both healthy and glaucoma eyes. In addition, RI is higher in people of AD for healthy eyes but is lower for glaucoma eyes. When considering only the differences in IOP, SBP, and DBP (simulation A(0)) in the model, the results did not follow the trend of the clinical study. The differences between ED and AD in PSV, EDV and RI (D-PSV, D-EDV, D-RI) were used as comparative metrics. When higher blood viscosity (BV) was considered for people of AD (A(1) and A(2)), the simulation results showed a similar trend in all metrics as reported clinically for heathy eyes (Tab.2). In glaucoma eyes, the D-EDV trend was captured by increasing BV.

Conclusions : This study shows that accounting for different blood viscosity, in addition to SBP, DBP and IOP, helps explain the differences in PSV, EDV, and RI documented among healthy eyes of ED and AD. In glaucoma eyes, ED-AD differences in EDV were captured. Future research is directed at ascertaining

the role of vessel diameter, capillary density and regulatory function on the CRA blood flow, especially in glaucoma eyes.

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