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ARVO Annual Meeting Abstract | June 2023

Relationship Between Blood Velocity in the Central Retinal Artery and Cardiac Systolic Function: a Theoretical Study

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Footnotes

Commercial Relationships **Mohamed Zaid** None; **Alon Harris** AdOM, Qlaris, Luseed, Cipla, Code C (Consultant/Contractor), AdOM, Luseed, Oxymap, Qlaris, Phileas Pharma, SlitLed, QuLent, Code I (Personal Financial Interest), AdOM, Qlaris, Phileas Pharma, Code S (non-remunerative); **Lorenzo Sala** None; **Marcela Szopos** None; **Sergey Lapin** None; **Gal Antman** None; **Jeffrey Kuvin** None; **Brent Siesky** None; **Alice Chandra Verticchio Vercellin** None; **Giovanna Guidoboni** Foresite Healthcare LLC, Code C (Consultant/Contractor), Qlaris, Code C (Consultant/Contractor), Gspace LLC, Code I (Personal Financial Interest)

Support NIH R01EY034718, NSF-DMS 2108711/2108665, NSF-DMS 1853222/2021192, NIH R01EY030851, NYEE Foundation grants, and in part by a Challenge Grant award from Research to Prevent Blindness, NY

Investigative Ophthalmology & Visual Science June 2023, Vol.64, 1994.
doi:

Abstract

Purpose : Non-invasive assessments of left ventricular contractility (LVc) are needed to diagnose and treat cardiac systolic dysfunction. Ocular measurements have the potential to provide a window on the heart. To this end, this study investigates the relationship between LVc and blood velocity in the central retinal artery (CRA) and how this relationship is affected by intraocular pressure (IOP).

Methods : A mathematical model of the cardiovascular system, previously validated on a preclinical model of myocardial infarction on swine, is used to predict alterations in systemic arterial and venous pressures associated with LVc reductions. A validated mathematical model of the retinal circulation is used to

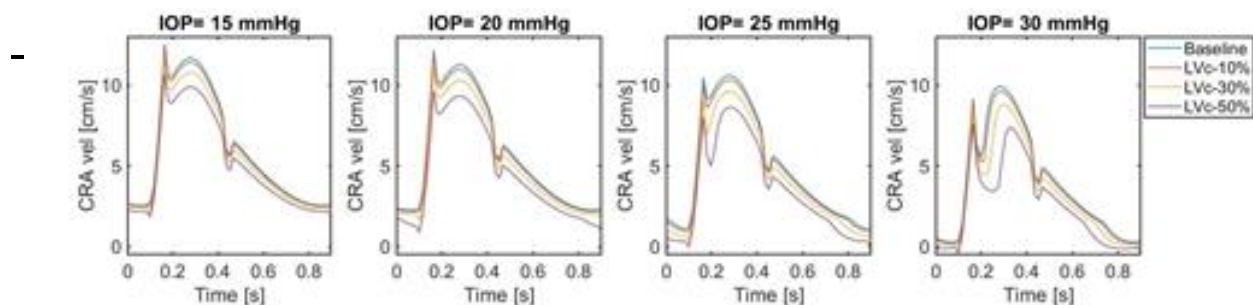
predict alterations in the CRA velocity waveform due to: (i) LVc-induced changes in systemic pressures, and (ii) IOP elevation. LVc reductions of 10%, 30% and 50% with respect to baseline are considered, for IOP values of 15, 20, 25, and 30 mmHg.

Results : Simulation results suggest that LVc reductions induce a decrease in CRA peak systolic velocity (PSV) and end diastolic velocity (EDV). This decrease is more marked for higher IOP. When IOP = 15 mmHg, LVc-50% induces PSV and EDV to decrease of 24% and 15%, respectively. However, if IOP = 20 mmHg, LVc-50% induces PSV and EDV to decrease by 26% and 43%, respectively. When IOP = 30 mmHg, LVc-50% yields negative EDV, indicative of CRA flow reversal. IOP elevation induces a smaller PSV decrease than that induced by LVc reductions. When LVc is at baseline and IOP increases from 15 to 20 mmHg (33% increase), PSV decreases by 3%. When IOP is at 15 mmHg and LVc is reduced by 10% and 30%, PSV decreases of 5% and 13%, respectively. IOP elevation has a characteristic

effect on EDV, which decreases significantly due to higher susceptibility to venous collapse in the retinal circulation.

Conclusions : This theoretical study proposes that LVC reductions lead to characteristic changes in the CRA blood velocity waveform that are distinguishable from changes related to IOP elevation. These results suggest that measuring CRA velocity may offer novel noninvasive ocular imaging access to cardiac systolic function, which may open to new experimental research to investigate the relationship between patients' visual field deterioration and their cardiac health.

This abstract was presented at the 2023 ARVO Annual Meeting, held in New Orleans, LA, April 23-27, 2023.



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PSV /EDV [cm/s]	IOP = 15 mmHg	IOP = 20 mmHg	IOP = 25 mmHg	IOP = 30 mmHg
Baseline	11.67/2.54	11.26/2.24	10.60/1.06	9.92/0.27
LVc-10%	11.03/2.50	10.60/2.18	9.93/0.94	9.24/0.21
LVc-30%	10.19/2.38	9.70/1.93	9.03/0.67	8.25/0.05
LVc-50%	8.88/2.17	8.30/1.27	7.62/0.33	6.51/-0.15

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