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Glaucoma Pressure Physiology: Need for Innovation

Karan R Gregg Aggarwala*

A Division of Ben Vision Research, OAMRECS: Ocular and Metabolism Research Education Consulting Sales, USA

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***Corresponding author:** Karan R Gregg Aggarwala, OAMRECS: Ocular and Metabolism Research Education Consulting Sales, A Division of Ben Vision Research, 1410 York Avenue, New York, USA

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Abstract

Although there could be far greater critical remarks from patients and their caregivers, as a physician-scientist my commentary is intended for doctors and surgeons managing glaucoma to recognize the need for greater attention toward the science of intra-ocular pressure. The physiological aspects touched upon in this manuscript are influenced by neurology, vascular function and nutrient assimilation. There is not one ocular tonometry method or commercial diagnostic instrumentation for glaucoma that adequately includes effects of such physiological determinants of internal fluid eye pressure.

Keywords: Glaucoma pressure; Physiology; Innovation; Neurology; Vascular function; Nutrient assimilation; Ocular tonometry; Diagnostic instrumentation

Introduction

Despite known variations to eye pressure from cardiac and respiratory breathing effects: at a time-course around 1.2 seconds [75 beats per minute] to 12 seconds [5 cycles per minute of the abdominal diaphragm]; single, momentary tonus measurements of Intraocular Pressure (IOP) are considered an appropriate, adequate criterion for clinical medication or surgery for glaucoma [1]. Some problems with such an approach have emerged since Whitacre and Stein (1993), but few doctors are cognizant.

Pulsatile pressure

It is not sufficiently appreciated that pulsations of eye pressure and other variations of IOP were once at the centre of attention for ophthalmology research [2-4]. Today however, pulsations and short-term [1.2 second to 12 seconds duration] pressure variations are not used for clinical decision making. However, on the scale of 24 hours: diurnal tonometry has been used widely [5-7] despite inconvenience to the patient and dubious efficacy [8-10].

Osmosis and eye fluid

Mechanisms for production of aqueous humor are not fully understood, but it is posited that the Non-Pigmented Ciliary Epithelium (NPCE) anterior to the choroid, is necessarily involved [11]. Recollecting the "Water Drinking Provocative Test," It seems reasonable to suggest that osmotic factors starting in the early intestinal fluid viscosity should play a role. The bicarbonate ionic mechanisms posited at the NPE might NOT be more primary than osmosis.

Dynamic anatomy and neurology influences

Regulation of aqueous humor drainage is better understood as anatomy, but not well established as far as a physiological model including fluid dynamic rate of flow and neurology [12-16]. Pressure differential at the two chambers anterior to the vitreous might be regulated by pupil neurology and mechanics as the iris sphincter appositionally opens and closes at the margin of the anterior lens. Electron microscopy imaging at the Inner Wall of Schlemm's Canal (IWSC) is informative [17] but the factors controlling rate of vacuole formation and vesicular bubble pore size for draining internal eye fluid, remain unknown.

Biophysics, histology, inflammation

The flexible and contractile Juxta-Canalicular Tissue Trabecular Meshwork (JCT-TM) is composed in part of collagen, but white blood lymphatic corpuscles emerge and depart with unknown frequency. To maintain the JCT-TM adequately fenestrated physically, is most necessary but biological metabolism and biophysical stressors are barely understood [18]. By simplistic counting of cells it is hard to know whether they serve inflammatory process and gathered in excessive numbers, or whether their main function is phagocyte engulfing of bacteria fragments and debris.

Success and failure

Recent year post-millennium effort to understand glaucoma physiology [19-21] published 2013-2017, has been monumental. Design and results of long-term clinical trials between 1992 and 2005 were not adequately addressing physiological antecedents of eye pressure regulation. Today, it appears necessary that innovation for measurement of eye pressure be directed from a solid understanding of ocular biophysics combined with neural, metabolic and vascular factors. Corneal thickness does not completely represent the mechanics of the cornea and therefore a reasonably good estimation of corneal elastic resistance could be a valuable addition to any new advanced instrumentation for ocular tonometry.

New understanding

When prostaglandins [22,23] were introduced in year 1994, the author observed, that prior standard clinical protocol of beta-blocker eye drop twice daily was suddenly overturned [24]. Today, a well-described study from mainland China criticizes prostaglandin analog eye drops [25] and we are faced with a conundrum. We need to temporarily favor prior drugs until diagnostic technology reveals better and safe pharmaceutical targets. The genius and dedication of Hans Goldmann [26] might serve as inspiration.

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