Biomechanics of glaucoma: factors influencing the intraocular pressure

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Abstract

We present a simple biomechanical model, based on the works of Collins et al. [1,2,3], which describes volume and pressure changes within the eye as functions of measurable ocular properties. We suppose that the rate of the volume change of the whole ocular is the sum of the rate of volume change of the ocular arterial bed and the rate of volume change of the aqueous humor. The mechanical characteristics of the cornea and sclera are expressed throughout by the so-called ocular rigidity function. Blood flow circulation within the eye is represented as if from an equivalent vessel, that is, a single cylindrical vessel represents the whole vascular bed. The aqueous humor dynamics are predisposed by the difference between production and outflow. Finally, an ordinary differential equation was derived for the intraocular pressure. In this equation, the rigidity of the corneoscleral envelope and the blood vessels, the production, critical pressure and outflow of aqueous humor remain constant. The variation of their values over the suitable physiological range elucidates the interdependence of the intraocular pressure (IOP) on those parameters.

The results of the parametric study can be summarized as follows: 1) The arterial blood pressure in the ocular bed practically does not affect the IOP; 2) The increased rigidity of the corneoscleral envelope increases IOP slightly; 3) The parameters describing the aqueous humor production can either increase or diminish IOP significantly; 4) The resistance to aqueous outflow plays a determining role in increasing the IOP.

Keywords: Glaucoma, intraocular pressure, mathematical model