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ARVO Annual Meeting Abstract | June 2024

# The impact of trabecular meshwork permeability on circadian rhythms of intraocular pressure

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Investigative Ophthalmology & Visual Science June 2024, Vol.65, 1259.  
doi:

## Abstract

**Purpose :** To investigate the influence of trabecular meshwork (TM) permeability on the 24-Hr cycle of intraocular pressure (IOP).

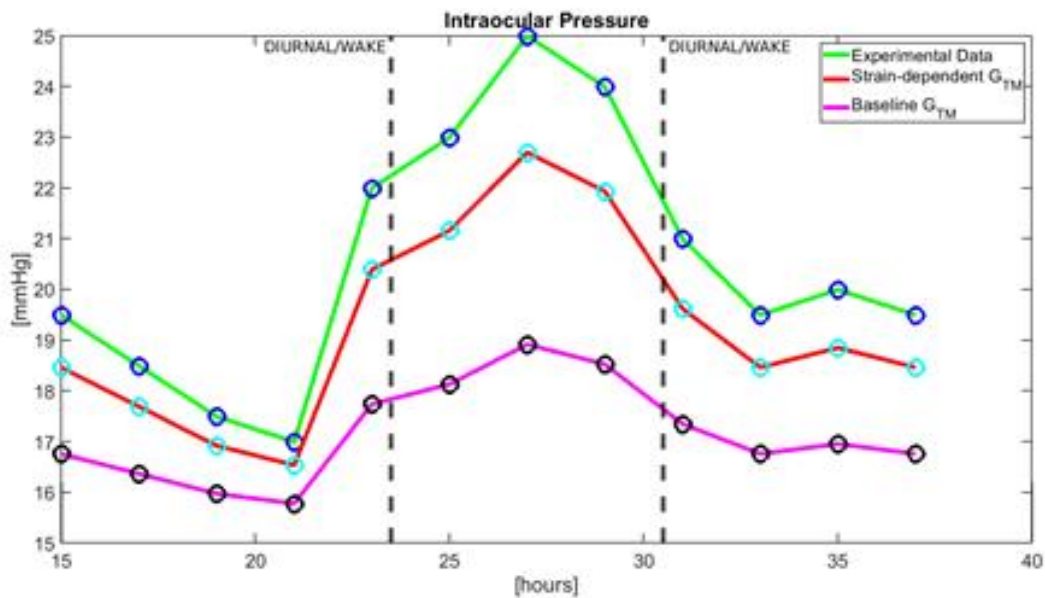
**Methods :** Experimental data demonstrate that IOP varies with circadian rhythm, being higher in nocturnal/sleep period and reaching a maximum percentage variation of ~50% with respect to the diurnal/wake period. To provide an interpretation of IOP variation we develop a mathematical model of TM conductance  $G_{TM}$  based on representing the TM as an incompressible poroelastic medium in a radially symmetric geometry. Assuming a strain-dependent permeability,  $G_{TM}$  results to be a sigmoidal function of pressure drop between anterior chamber and episcleral vein (EV). EV and suprachoroidal pressures are set to 8 and 11 mmHg, respectively. Ciliary capillary (CC) pressure varies with circadian rhythm and is determined from IOP experimental data in Liu et al, 2023 (ED) and a phenomenological relation between IOP and CC volume proposed in Kiel et al, 2011.

**Results :** Fig. 1 illustrates the simulation of the 24-Hr IOP rhythm. The green curve shows the ED. The red and magenta curves show model predictions using the strain-dependent  $G_{TM}$  and  $G_{TM}$  at baseline conditions, respectively. Results demonstrate that the

proposed model reproduces the ED more accurately than the standard model. Fig. 2 illustrates the simulated 24-Hr rhythm of aqueous humor production rate (AHPR, colors match those in Fig. 1). Results indicate that the standard model of G<sub>TM</sub> significantly overestimates AHPR with respect to the proposed model.

**Conclusions :** A computational virtual laboratory is developed to study IOP 24-Hr circadian rhythm on the basis of a theoretical model of AH production, diffusion and drainage which accounts for pressure-dependent TM outflow conductance. Preliminary simulation results support the conjecture that the TM behaves as an adaptive drainage route capable of adjusting its value to the driving outflow pressure difference. The developed computational virtual laboratory provides a quantitative tool to complement *in vivo* studies that may help design and optimize medications for ocular diseases.

This abstract was presented at the 2024 ARVO Annual Meeting, held in Seattle, WA, May 5-9, 2024.



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Simulation of IOP over 24 Hrs. Green curve: experimental data. Red curve: IOP prediction using the proposed model. Magenta curve: IOP prediction with a constant  $G_{TM}$

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Simulation of AHP, Q\_AH, over 24 Hrs. Red curve:  
Q\_AH prediction using the proposed model. Magenta  
curve: Q\_AH prediction with a constant G\_TM

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