Developing a micro check valve for flow control in a novel glaucoma implant

Student project

Introduction

Glaucoma is the leading cause of preventable blindness worldwide, estimated to cause bilateral blindness in 11 million people by 2020 [1]. A rise in the intraocular pressure (IOP) is considered to be the major risk factor for glaucoma, and is associated with an unbalance between the production and drainage of aqueous humor (AqH) due to an abnormal increase of resistance to AqH outflow from the anterior chamber.

Glaucoma drainage devices (GDDs), which are typically hollow tube-like shunts, surgically implanted in the eye, provide an alternative pathway through which AqH can effectively exit the anterior chamber, thereby lowering IOP (Fig. 1) [2]. However, postoperative IOP is unpredictable and current GDDs often fail to maintain it at optimal levels, which can lead to serious postsurgical complications such as hypotony (i.e. low IOP).

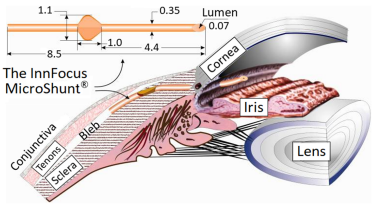

Figure 1: An example of a GDD: the InnFocus MicroShunt including its dimensions (mm) and placement in the eye [2].

Project description

The aim of this project is to design, fabricate and characterize a micro check valve to integrate in a novel glaucoma implant. The final device will not only drive the AqH from the anterior chamber into a filtering bleb (Fig. 2) [3], but it will also allow us to effectively maintain the IOP within the normal range (10-15 mmHg). A possible concept of the valve and respective operating principle is illustrated in Fig. 3: when the IOP is higher than the cracking pressure of the valve, the valve opens and allows the excess AqH to drain. In contrast, the valve remains in a closed (or almost closed) state when the IOP is lower that the cracking pressure [4].

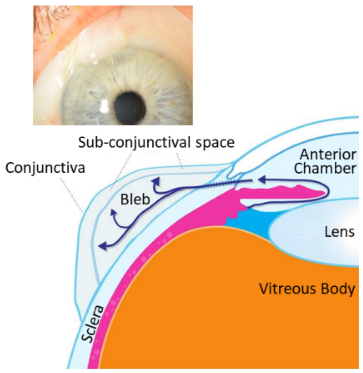

Figure 2: Bleb formed by subconjunctival drainage of AqH [3].

Main project goals:

- Development of a microfluidic device with integrated micro check valve.
- Testing and optimization of different valve membrane thicknesses to achieve the desired cracking pressure.
- Building an experimental set-up for evaluating the flow control properties of the fabricated device.

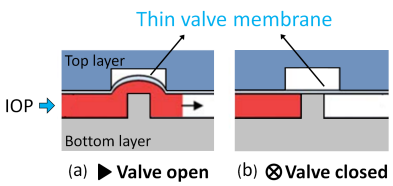

Figure 3: Cross-sectional view and operating principle of the micro check valve: **(a)** the valve in an open state and **(b)** the valve in a closed state [4].

References

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2. J.F. Batlle, *et al.*, "Three-Year Follow-up of a Novel Aqueous Humor MicroShunt", *J Glaucoma*, 2016.
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4. C.J. Park, *et al.*, "Polymeric check valve with an elevated pedestal for precise cracking pressure in a glaucoma drainage device", *Biomed Microdevices*, 2016.

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