

Abstract

Magnetically Actuated Glaucoma Drainage Device with Adjustable Flow Properties after Implantation [†]

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Abstract: Glaucoma is the second leading cause of preventable blindness worldwide, following cataract formation. A rise in the intraocular pressure (IOP) is a major risk factor for this disease, and results from an elevated resistance to aqueous humor outflow from the anterior chamber of the eye. Glaucoma drainage devices provide an alternative pathway through which the aqueous humor can effectively exit the eye, thereby lowering the IOP. However, post-operative IOP is unpredictable and current implants are deficient in maintaining IOP at optimal levels. To address this deficiency, we are developing an innovative, non-invasive magnetically actuated glaucoma implant with a hydrodynamic resistance that can be adjusted following surgery. This adjustment is achieved by integrating a magnetically actuated microvalve into the implant, which can open or close fluidic channels using an external magnetic stimulus. This microvalve was fabricated from poly(styrene-*block*-isobutylene-*block*-styrene), or ‘SIBS’, containing homogeneously dispersed magnetic microparticles. “Micro-pencil” valves of this material were fabricated using a combination of femtosecond laser machining with hot embossing. The glaucoma implant is comprised of a drainage tube and a housing element fabricated from two thermally bonded SIBS layers with the microvalve positioned in between. Microfluidic experiments involving actuating the magnetic micro-pencil with a moving external magnet confirmed the valving function. A pressure difference of around 6 mmHg was achieved, which is sufficient to overcome hypotony (i.e., too low IOP)—one of the most common post-operative complications following glaucoma surgery.

Keywords: glaucoma; intraocular pressure (IOP); adjustable glaucoma implant; magnetic microvalve; microfabrication

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