Recent Advances in the Understanding and Treatment of Glaucoma

An Expert Interview with Brandon Baartman and John Berdahl

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John Berdahl

John Berdahl specializes in advanced cataract surgery, corneal surgery, and glaucoma surgery, in addition to refractive surgery. Dr Berdahl completed his ophthalmology residency at Duke University and completed a fellowship in advanced anterior segment surgery at Minnesota Eye Consultants with Dr Richard Lindstrom. He is now the director of the fellowship at Vance Thompson Vision in Sioux Falls, South Dakota.

Keywords

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Glaucoma is one of the leading causes of irreversible blindness worldwide, and is therefore an active area of clinical research. Recent advances have enhanced our understanding of glaucoma as well as presenting promising treatment options. Until recently, its pathology has been considered to be restricted to the eye. However, recent research suggests that glaucoma involves the central nervous system, with cerebrospinal fluid pressure (CSFp) emerging as a potential modifiable risk factor. Biomechanical characteristics dictate how the eye responds to a given pressure, and this is also the focus of current research. In addition, the emergence of minimally invasive glaucoma surgery (MIGS) offers a safe alternative to traditional surgical techniques. In an expert interview Drs Brandon Baartman and John Berdahl of Vance Thompson Vision in Sioux Falls, South Dakota, discuss these advances.

Q: What is the role of cerebrospinal fluid pressure in the pathogenesis of glaucoma?

Glaucoma has classically been thought of as a one-pressure disease, with the only modifiable risk factor being intraocular pressure (IOP). However, increasing experimental and clinical evidence suggests that CSFp may be just as important. In retrospective studies on patients having undergone lumbar puncture, patients with primary open angle glaucoma were found to have lower CSFp than healthy controls. Interestingly, patients with normal tension glaucoma had even lower CSFp, while patients with ocular hypertension had higher than normal CSFp.[1,2]

Cerebrospinal fluid bathes the central nervous system, extending along the optic nerves to the lamina cribrosa, which acts as a barrier between two independently-pressurized compartments (IOP and CSFp). It is now being hypothesized that a root cause of glaucoma may be due to a disturbance in the pressure gradient across the lamina cribrosa, which has been shown to be associated with objective findings in advanced glaucoma.[3]

Q: How have advances in ocular biomechanics enhanced our understanding of glaucoma?

Investigations into the cause of glaucoma have been expanding to evaluate not only the pressures on the optic nerve, but also the biomechanical characteristics of an eye that dictate how it responds to a given pressure. One of the biomechanical markers that has been implicated in glaucoma pathogenesis is corneal hysteresis (CH). Contrary to common belief, CH is not a static property of an eye, but rather a measure of its ability to absorb a pressure change. Put differently, CH may help us understand the mechanical effect of an IOP change on an eye, and possibly, its resistance or susceptibility to nerve damage. Several studies have reported a significantly lower CH in patients with a variety of glaucoma subtypes compared to healthy controls, and others have correlated CH to structural change at the optic nerve head independent of IOP.[4] Further investigations into the utility of CH and other biomechanical properties of the eye are ongoing and hold promise for future diagnosis and management of glaucoma.

Q: What environmental factors have been associated with an increased risk of developing glaucoma?

While socioeconomic, nutritional, and environmental factors have been strongly linked to a number of systemic and ocular health conditions, there is a paucity of significant evidence for direct effects of outside factors on presence or progression of glaucoma. However, considering the established connection between IOP and glaucoma, some of these factors may be indirectly linked to glaucoma. Some activities which have been documented to increase IOP include playing wind instruments, wearing neckties, drinking coffee, and practicing certain yoga positions (e.g., a headstand), while other activities such as exercise and ingestion of alcohol have been posited to at least transiently reduce IOP.[5] Additional factors such as cigarette smoking and low consumption of certain dietary fats are being investigated, but no strong evidence exists to date.

As we learn more about CSFp and its relationship to glaucoma, some factors that cause low CSFp may garner higher interest in their relationship to glaucoma risk. Body mass index is one physiologic parameter which has been shown to be inversely related to CSFp, and may be linked to glaucoma risk. Finally, body positioning and the effect of gravity on CSFp are also factors actively being investigated for their role in glaucoma risk.

Q: At present, which glaucoma patients are most likely to benefit from the use of MIGS?

MIGS encompasses a wide range of technologies and procedures aimed at reducing intraocular pressure with an *ab interno* approach. There are a number of gonioscopic, angle-based surgeries that attempt to increase aqueous outflow and have various levels of effect on IOP, either in conjunction with or independent of cataract surgery. Most MIGS procedures are suitable for patients with mild-to-moderate primary open-angle glaucoma, and some have shown efficacy in secondary types of glaucoma including pigment dispersion and pseudoexfoliative glaucoma.[6] Because of the huge variety in procedure type and mechanism of IOP lowering, we see an equally wide distribution of effect on IOP, and it becomes a matter of risk-to-benefit ratio for each individual patient. In a patient with ocular hypertension and early glaucomatous visual field loss, choosing a trabecular bypass (iStent, Glaukos) will often achieve an IOP goal without taking on significant risk. In patients with more significant visual field loss failing topical therapy, diversion of aqueous to the suprachoroidal (Cypass, Alcon) or subconjunctival space (Xen, Allergan) may achieve lower postoperative IOP, and may balance out any perceived increase in procedural risk.

Q: What is most promising about MIGS technology or other *ab interno* glaucoma surgery?

One of the most beautiful things about MIGS procedures, in addition to their favorable risk profiles, is the preservation of future surgical options should the need arise. In this way, future trabeculectomy and tube shunts are not precluded by the use of MIGS procedures. Because they work via a variety of mechanisms, many MIGS procedures can also be complimentary to other procedures as well. For example, the combination of a trabecular bypass stent with endocyclophotocoagulation hits both aqueous outflow and production and might be suitable for a patient in need of more drastic IOP lowering than either one alone. There are many newer technologies in the pipeline as well, which make this an exciting time to be a glaucoma specialist. □

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