Editorial

Intraocular pressure: The endless adventure with new challenges

The last decade has witnessed impressive advances in the technology of digitalized imaging for glaucoma evaluation, the introduction of fixed combination medication, novel surgical techniques for glaucoma management, and continuing research to explore risk factors and therapeutic agents that are not intraocular pressure (IOP) dependent. Yet, the imaging technology cannot replace expert experience in the diagnosis and follow-up of glaucoma and IOP-lowering therapy remains the cornerstone in the management of glaucoma. In this issue, Dr. Shan Lin reviewed the findings and limitations of anterior segment optical coherence tomography regarding its application in glaucoma, and several authors shared their experience in the control of IOP by using different treatment modalities.

The history of IOP-lowering therapy for glaucoma can be traced back to the 19th century, but sound evidence supporting the efficacy of IOP-lowering in glaucoma was not available until the implementation of several prospective, randomized, multicenter clinical studies. The Ocular Hypertension Treatment Study (OHTS) demonstrated that a reduction of IOP from baseline by 20% or more decreased the incidence of glaucoma conversion in 5 years from 9.6% to 4.5%. For cases with established glaucomatous visual field defects, the Early Manifest Glaucoma Trial (EMGT), the Collaborative Initial Glaucoma Treatment Study (CIGTS), and the Advanced Glaucoma Intervention Study (AGIS) all showed a lower risk of progression in association with a reduction in IOP. Even for glaucoma with pretreatment IOP within normal limits, the Collaborative Normal Tension Glaucoma Study (CNTGS) showed an IOP reduction of 30% or more benefits those eyes which had prior visual field progression, field defect threatening the center, and disc hemorrhage.

Although the importance of IOP reduction in glaucoma is well recognized, some uncertainty exists about how much the IOP should be lowered or what numerical pressure measure is safe for most patients. Target pressure is a range of IOP within that no further damage to the optic nerve is expected to occur. There are different ways to estimate target pressure, but no data exist to date to support an ideal approach. A simple way is to set the target based on the extent of existing optic nerve damage. For ocular hypertension, an IOP-lowering of 20% ~ 25% is suggested for eyes with high risk of conversion to glaucoma if left untreated. For eyes with early, moderate, and advanced visual field defects, to control the IOP within a range not higher than 18 mmHg, 15 mmHg, and 12 mmHg, respectively, is often recommended. Since large variation in the rate of visual field progression exits among patients, ophthalmologists may want to reset the target pressure when data of subsequent changes in the structure/function of the optic nerve are available with longer follow-up.

An ongoing debate about IOP is which aspect of IOP, e.g., the mean, the fluctuation, or the maximum, matters more in terms of glaucoma progression. Bengtsson and associates reported that, albeit mean IOP is a significant risk factor for progression, the visit-to-visit IOP fluctuation during an average of 8-year follow-up was not related to progression in participants of EMGT. Being launched back in 1992, the EMGT did not incorporate the idea of target pressure; thus, no further intervention would be suggested after randomization as long as progression did not occur and the IOP did not exceed 25 mmHg on two consecutive visits in the treatment arm or remained 35 mmHg or lower in the observation arm. Later on, Caprioli and Coldmann in a retrospective analysis of patients enrolled in the AGIS found, in addition to mean IOP and other variables, visit-to-visit IOP fluctuation was associated with visual field progression in patients with low mean IOP during follow-up (10.8 ± 2.5 mmHg) but not in patients with high mean IOP (20.6 ± 4.5 mmHg). They raised a hypothesis that greater IOP fluctuation is damaging in eyes with low mean IOPs; however, when the mean IOP is higher, the role of IOP fluctuation becomes less important. However, in a recent article, which included 607 participants of the CIGTS, Musch and associates found the three IOP summary measures (range of IOP, fluctuation of IOP, and maximum IOP) were significantly associated with progressive visual field loss over a period of 3- to 9-year among those treated medically (6-year mean IOP, 17.7 ± 2.6 mmHg), but not among those treated surgically (6-year mean IOP, 14.4 ± 3.8 mmHg). Above all the possible reasons which may explain the disparity in results across these studies, such as...
age, severity of glaucoma, treatment modality, data included to calculate various IOP measures, definition of progression, presence or absence of IOP-independent risk factors, and methods of statistical analysis, one fundamental shortcoming of all these studies is that IOP was measured at a 3- to 6-month interval. As a result, the alleged mean IOP or fluctuation of IOP probably is not the true average or variation of pressure acting on the optic nerve head/retinal ganglion cells throughout the follow-up period.

Although IOP can readily be measured with a variety of tonometers, ophthalmologists in fact know little about their patients’ IOP profile over time. Due to the variable nature of IOP, it is evident that the IOP measure obtained in office within a short interval of minutes reveals little of the whole picture of the circadian and day-to-day variation of IOP. What further hinders us from appropriately estimating patients’ IOP control is that the peak circadian IOP usually occurs during off-office hours. In order to better understand patients’ IOP profile during the course of daily life, devices that enable us to measure IOP in a continuous way without interrupting sleep at night are desirable. After decades of search, a wireless ocular telemetry sensor which is based on the assumption that a correlation exists between IOP and corneal curvature has recently been introduced to continuously monitor IOP in patients with glaucoma.10,11 Although questions like whether the thickness and biomechanics of the cornea would affect the accuracy of its measure remain to be answered, it stands a chance to explore the enigmatic pressure within the eye.

References