

Diurnal Variation of IOP: The Triggerfish CLS

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Intraocular pressure is the most commonly identified risk factor and the only one which can be modified, in patients of glaucoma. Decrease in IOP has shown to be effective in retarding the progression of glaucoma, over a wide spectrum of disease, regardless of baseline IOPs. In addition, there is considerable evidence that IOP variables

including peak levels and fluctuations (both short term and over longer periods) adversely impact the disease development and progression, acting as independent risk factors.

Why is 24 hour IOP monitoring essential?

Circadian fluctuation of IOP is known to be one the major risk factor for visual field progression in both PACG and POAG patients. IOP spikes have also been related to progressive visual field loss. Moreover, increased diurnal variation in IOP is an independent risk factor for glaucoma progression.¹

According to various studies, glaucomatous progression occurs despite adequately controlled IOP measured in the office.

Various investigators have concluded that only office hours IOP recordings can be fallacious and are not enough for the management of glaucoma. Peak IOP occur outside office hours in almost half of our patients, with as many as 35% patients undergoing an immediate treatment change, following 24 hour IOP monitoring.

What are the options for 24 hour IOP monitoring?

A. Hospitalisation for IOP

The most important consideration for this is issues of cost and access. Moreover, one must ensure that the same tonometer is used in both sitting and supine positions. Therefore, options include the Tonopen, Pneumatonometer, and Perkins.

Also, the same person must do the entire diurnal variation curve, to remove inter-observer bias.

B. Patient self-tonometry

This is fraught with questions about reliability of the readings. Also, since the patient wakes up, and sits up to

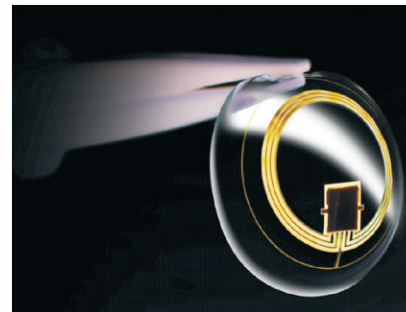
take the readings, they are not really physiological records of IOP. Home tonometers which may be used include the I-care one, Zeimers, and Proview.

C. Sleep laboratory

Sleep labs provide the best analog for physiological IOP curves, however, they are expensive, and few.

What is currently the best bet for 24 hour IOP monitoring?

The triggerfish contact lens sensor (Sensimed, Switzerland) is a disposable silicon contact lens with an embedded micro electrical system,² which measures changes in corneal curvature induced by variation in IOP (Figure 1). In use in Europe with a CE mark for almost a decade, this device has recently received approval by the US FDA as well.



*Figure 1:
Triggerfish CLS
sensor for 24 hour
IOP monitoring*

The Triggerfish is a silicon soft contact lens 14.1 mm in diameter and 585 μm in thickness in center. The device has 3 base curves (8.4, 8.7 and 9 mm) for a better fit, depending on the patient's corneal curvature (Figure 2). Embedded within the center are two strain gauges, a microprocessor and an antenna.³⁻⁴



*Figure 2:
Patient wearing the
Triggerfish CLS sensor
for 24 hour
IOP monitoring*

These strain gauges detect changes in corneal shape, which correlates the CLS output and imposed IOP. The contact lens receives power from and transmits strain gauge information to an adhesive antenna that is pasted around the eye of the patient.

This antenna sends information to the portable recorder, which is worn by the patients around their waist, much like the holster used for ambulatory ECG recording.

What is remarkable is that the Triggerfish CLS takes 300 readings over 30 second period every 5 minutes (Figure 3).⁵ This means that a total of 86,400 data points corresponding to IOP are recorded over a 24 hour period. This data is sent via blue tooth to a computer for analysis. The data points are measured in millivolts or millivolt equivalent, and are known to correspond to IOP fluctuations.^{6,7}

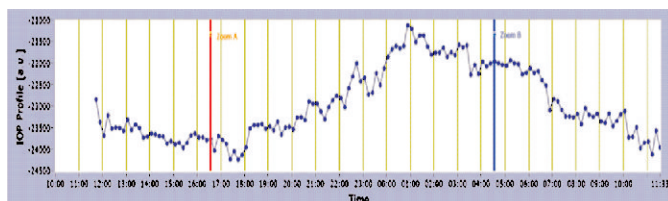


Figure 3: Diurnal variation in IOP as recorded by Triggerfish CLS sensor during 24 hour IOP monitoring

What is the current status of the Triggerfish CLS

The biggest advantage of the CLS is that the patient can be ambulatory during the measurements. The recordings therefore are true physiological IOP levels during the patients' daily activities. The patient is also encouraged to keep an activity log so that changes in IOP can be correlated with the activities at that time. Therefore appropriate feedback can be provided especially in regard to lifestyle modification.³

Various clinicians and researchers have found that the device is well accepted and tolerated by patients, with few complications. The CLS has been used to determine both diurnal variation in eyes of PACG and POAG, as well as to

ascertain the effects of glaucoma therapy, both topical and following laser treatment.

The biggest disadvantage of the CLS is that the readings are in milli volt equivalent rather than mmHg. The recordings therefore cannot be interpreted as IOP in the clinical situation, since the relationship between the two parameters is nonlinear and influenced by viscoelastic properties of eye. Its other disadvantage is its high cost, since the device sensor is a disposable CL.

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Tocilizumab benefits patients with refractory CME

Researchers retrospectively assessed the effectiveness of tocilizumab in 25 patients with persistent cystoid macular edema (CME) secondary to noninfectious uveitis. Twelve months of tocilizumab therapy significantly improved macular thickness and BCVA and cut the mean dose of prednisone from 15.9 to 3.1 mg/day. Fourteen patients achieved remission and only minor side effects were noted. The authors conclude that patients treated with tocilizumab generally experience a quick and maintained response. *American Journal of Ophthalmology*, April 2019