Laser Flare Photometry: An Under-Utilised Investigative Tool For Anterior Segment Inflammation

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Slit lamp examination is an important clinical method for microscopic evaluation of anterior segment inflammation. However, it is observer dependent and existing grading systems are subjective with limited reproducibility. Laser flare photometry is an objective quantitative tool to analyze aqueous flare non-invasively and accurately. It allows precise monitoring of clinical activity in uveitic disorders, prediction of recurrence, detection of persistent subclinical disease and comparison of effects of different surgical techniques and anti-inflammatory agents despite such advantages, it remains an underutilised investigative tool in day to day clinical practice. Clinicians should explore this potential instrument and identify its appropriate use in diagnosis, management and follow-up of ocular disorders.

Keywords: anterior segment inflammation, laser flare photometry

Abstract

Aqueous flare and cells are the two key parameters for grading anterior segment inflammation. Standardization of Uveitis Nomenclature (SUN) working group classification for aqueous cells and flare is subjective with considerable intra-and inter observer variability. Newer accurate and more reproducible technologies for anterior segment inflammation quantification include laser flare photometry (LFP) and ocular flare analysis meter (OFAM). LFP is an objective method that allows measurement of aqueous flare with high accuracy and reproducibility. Though introduced in 1988 in Japan, LFP has not been integrated into clinical practice worldwide till date.

Introduction

Healthy adults have aqueous flare intensity in the range of 2.9–3.9 ph/ms. Laser flare intensity is known to correlate significantly with protein concentration both in vitro and in vivo. Flare counts also correlate with clinical grades of flare at the slit lamp. LFP measurement may be influenced by many physiological factors that alter aqueous protein levels or influence amounts of reflected light. Factors that are known to affect LFP measurements are given in Table 1.

Principle

LFP is based on the principle of light scatter detection. The laser flare photometers use helium-neon or diode laser to scan a given volume of anterior chamber. Back-scattered light from small molecules such as aqueous proteins (flare) is detected by a photomultiplier which generates an electrical signal. This is then digitized, processed and displayed by a computer. The intensity of the scattered light is proportional to the amount and size of proteins in the aqueous humour. It is calculated as ‘flare counts’ or ‘photon (ph) count’ per millisecond.

Models

Laser flare photometers were initially based on slit-lamp construction principle. The Kowa FM-500 (Kowa Optimed, Tokyo, Japan) was the first commercially available flare-meter. FM-600 flare-meter is an FDA approved advanced model which uses a 635nm semiconductor laser diode. It has a 0.5 second measuring time with a measuring field of vertical 0.3 mm x horizontal 0.5 mm. The latest model in the series, FM-700 has a slit-lamp design-type of binocular stereoscopic microscope attached with it. It provides magnification up to 40X and a continuously variable slit width from 0 to 11 mm and slit length from 1 to 9 mm. Slit-lamp-based model allow manual adjustment in eyes with suboptimal measurement conditions such as corneal opacity, posterior synechiae or high-grade inflammation.

Procedure

After initial chin adjustment and anterior segment alignment (working distance and measuring point adjustment), measuring window is displayed on LCD screen. On confirming the colour and form of measuring window, machine takes seven measurements of flare. The highest and lowest values are discarded and the mean and standard deviation of the remaining five readings are automatically calculated and displayed.

Clinical uses

Healthy adults have aqueous flare intensity in the range of 2.9–3.9 ph/ms. Laser flare intensity is known to correlate significantly with protein concentration both in vitro and in vivo. Flare counts also correlate with clinical grades of flare at the slit lamp. LFP measurement may be influenced by many physiological factors that alter aqueous protein levels or influence amounts of reflected light. Factors that are known to affect LFP measurements are given in Table 1.
Table 1: Physiological parameters affecting laser flare photometry measurement.

| Parameter         | Effect on LFP Measurement | Mechanism                                                                 |
|-------------------|---------------------------|---------------------------------------------------------------------------|
| Mydriasis         | Decrease with pupillary dilatation | Decrease backscatter from iris, pharmacological effect of mydriatic agent |
| Aging             | Increase with aging       | Breakdown of blood aqueous barrier leading to true increase in protein concentration, increased light scatter caused by cataract |
| Diurnal variation | Increase in daytime       | Increase in protein-free aqueous humour flow rate during day              |
| Protein composition | Increase if high molecular weight proteins increase (albumin and immunoglobulin) | Rayleigh law (scattering is dependent on molecular weight and concentration of protein) |
| Drugs             | Variable, Pilocarpine, timolol, acetazolamide, mannitol increase; tropicamide, phenylephrine decrease | Alterations of the blood–aqueous barrier, altered aqueous humour production |

Footnote: LFP* laser flare photometry

LFP is useful in follow-up observation and management of inflammation in uveitis and post surgery. The key domains where LFP may find its use are mentioned in Table 2.

Advantages

LFP is objective, precise, reproducible and reliable. It is simple, quick, non-contact and non-invasive alternative to slit lamp examination for aqueous flare. Slit-lamp examination allows only a subjective and arbitrary non-linear grading of cells and flare in the anterior chamber. On the other hand, LFP is a quantitative method to reliably measure intraocular inflammation.

Limitations

LFP is unreliable in eyes with extensive posterior synechiae or advanced cataract due to increased background scattering of light. FLP may not be performed in eyes with corneal opacity or very shallow anterior chamber.

Conclusion

LFP is an objective and accurate technique of intraocular inflammation assessment. It supplements slit lamp examination in diagnosis, management and monitoring of various ocular disorders (inflammatory or non-inflammatory). Its research applications and utility needs to be explored further.
Table 2: Clinical Uses of Laser Flare Photometry

| Domain                       | Clinical use                                      | Comment                                                                 |
|------------------------------|--------------------------------------------------|------------------------------------------------------------------------|
| **Anterior Uveitis**         | Monitoring of acute uveitis                       | Higher sensitivity than clinical slit lamp grading                      |
|                              | Prediction of exacerbation                        | Rising values predict recurrence well before clinical signs            |
|                              | Prediction of complications                       | High flare (in the absence of cells) acts as a risk factor for development of macular edema |
| Treatment of uveitis         | Treatment indicated in sub-clinically elevated flare after resolution of acute inflammation, high flare without cells in JIA associated uveitis |
| Cessation of steroid treatment | Evolutionary pattern of LFP helps in early tapering of steroid treatment, thereby avoiding side effects |
| Predicting recurrence        | If baseline anterior chamber inflammation is minimal |
| **Posterior uveitis**        | Alternative to FFA                                 | In cases with poor visualization of fundus, as LFP values correlate well with FA leakage |
|                              | Effect of anti-inflammatory agents                | Compare efficacy of NSAIDS and steroids                                 |
|                              | Cessation of steroid treatment                    | Early tapering of steroid treatment to prevent IOP rise and ocular surface disorder |
|                              | Biocompatibility of various IOLs                  | Variable effect of IOL material                                       |
|                              | Effect of heparin coating on IOLs                 | Heparinised IOL cause less postoperative inflammation                  |
| **Post cataract surgery**    | Monitoring of graft rejection                     | LFP could monitor effects of steroid therapy on rejection              |
| inflammation                 | Comparison of trabeculectomy and nonpenetrating surgeries | Lesser inflammation with deep sclerectomy                               |
|                              | Comparison of argon laser trabecuoplasty with diode laser trabecuoplasty | Lesser inflammation with diode laser                                   |
| **Glaucoma**                 | Predictor of DR                                   | Diabetic iridopathy can predict later development of DR               |
|                              | Effect of PRP or cataract surgery                 | Breakdown of blood aqueous barrier with surgery                        |
| **Diabetic retinopathy**     | Progression of disease                            | Deterioration of blood aqueous barrier occurs with progressive chorioretinal disease |
| (DR)                         | Role of Inflammation                              | Steroids play a role in management due to associated inflammation      |
| **Retinitis pigmentosa**     |                                                   |                                                                        |
| **Retinal vascular**         |                                                   |                                                                        |
| occlusions                   |                                                   |                                                                        |

Footnote: LFP Laser flare photometry, FFA Fundus fluorescein angiography, DR Diabetic retinopathy, IOP Intraocular pressure, IOL Intraocular lens, PRP Pan-retinal photocoagulation.
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