Ophthalmic Update

School of Medical Ophthalmic Technology, Continuing Education Course
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Christopher J. McDevitt, M.D.

Cataract Surgery

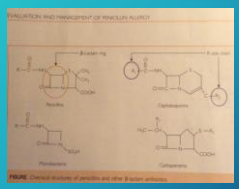
Antibiotic Prophylaxis, Penicillin Allergic Patients

- Decision tree involves assessment of true penicillin allergy. Consider:
  - Did reaction occur within one hour of drug exposure
  - Did the patient experience wheezing, hypotension, laryngeal edema, angioedema, urticaria and anaphylaxis
- True rate of immune mediated hypersensitivity is 5-10% of those reporting penicillin allergy.
- Of all patients risk is 0.01-0.04% of patients that true anaphylaxis occurs

Cross-Reactivity Between Penicillins and Cephalosporins

- Widespread belief of 10% cross-reactivity
- Recent studies show cross-reactivity between penicillins and cephalosporins less than 5%.
- Rate of cross-reactivity varies with the type of cephalosporin.
- The type of side chain determines the cross-reactivity.
- Cefuroxime and cephazolin are the most common administered cephalosporins.
- Cefuroxime and cephazolin have low rates of cross reactivity to penicillin
- If clinical history indicates a type 1 hypersensitivity then skin testing is recommended

Cross-Reactivity Between Penicillins and Cephalosporins



Antibiotic Prophylaxis Cataract surgery

- Topical antibiotics 2.66 times greater risk of endophthalmitis than intracameral antibiotics.
- If penicillin allergy may be reasonable to use cefuroxime as cross reactivity is small risk. If no anesthetist for surgery then next best would be moxifloxacin or vancomycin.
- Moxifloxacin has better greater benefit to risk ratio than vancomycin
- Recent cases of HORV with vancomycin make using this a concern
- Consider using topical moxifloxacin or ofloxacin one drop every 1 to 2 hours post-op the day of surgery.

Multifocal Intraocular lenses: overview

- Challenge: Use a non-physiological optical method to improve near vision
- Separate light into different foci causing dispersion of light entering the eye
- Overlapping of different foci is normal or physiological in mammals.
- Neuroadaptation is necessary to adjust neurophysiology induced by the quality of the retinal image
- New technologies aim to make a more physiological division of light
- MfIOLs are useful and provide good visual results
- Patient selection is key

MfIOLs: Factors and Considerations

- Patient age, needs, lifestyle and psychological profile
- The patient's clinical ophthalmic condition and associated eye problems especially those that have a negative impact on contrast sensitivity
- Pupil reactivity and size in different light environments
- Evidence published in peer review literature especially the defocus curve of the MfIOL
- The surgeons attitude, education and experience

MfIOls

- Focus light from distant objects and near objects at the same time
- Some light dispersed to no particular focus due to chromatic aberration, corneal opacities, diffraction from pupil edge and the total refractive error of the implanted eye
- These factors influence the performance of the IOL

MfIOLs

Refractive (Rezoom)

- Annular zones of different refractive powers providing appropriate good near and distance vision
- Provide adequate intermediate and distance vision and adequate near vision.
- May experience distortion at near

Diffractive (ReStore, Tecnis)

- Diffractive microstructures in concentric zones
- Distance vision from the optical power of the anterior and posterior lenses surfaces
- Near power from the anterior and posterior surface and the first order of diffraction
- Provide very good distant vision and good near vision. Intermediate vision is acceptable.

MfIOLs

- Refractive limitations: pupil dependence, high sensitivity for lens centration, intolerance to kappa angle varies patient to patient. Potential for halos and glare from rough areas between the refractive zones. Loss of contrast sensitivity
- Diffractive limitations less pupil dependent and more tolerant to kappa angle and decentration. Main disadvantage is energy lost caused by the light scattering of the diffractive surfaces. High potential for halo and glare. Cause 18% loss of light in transition
- May decrease the quality of vision in mesoptic and scotopic conditions

MfIOLs and Astigmatism

- Must be completely eliminated for MfIOL to be efficient
- The ability to use toric Mfiols is important
- MfIOL implants negatively influenced by corneal higher order aberration such as previous refractive surgery .

MfIOL Patient selection

- Main visual activities
- Tolerance to nighttime dysphotopsia, haloes, glare, small loss in contrast sensitivity
- Patient with unrealistic expectations and overly critical personalities
- Postop vision degradation form dryness, blepharitis, basement membrane dystrophy, corneal scarring, corneal edema, macular edema, lens decentration, PCO and astigmatism.
- Caution with monovision patients as neuroadaptation for a different situation monovision may be difficult transition

MfIOL Patient selection

- Use debatable in some clinical situations: pediatric cataract surgery
- Glaucoma patients with existing decrease in contrast sensitivity
- Any maculopathy that already decreases contrast sensitivity
- Possible beneficial effect in AMD with SE target -2.00 yields a +5.20 near add. This improved near vision without compromising corrected distance vison.
- Dry eye tear film irregularities and MfIOL implant may not be compatible. 15% of unsatisfied MfIOL patients had dry eye

MfIOL Patient Selection

- Monocular implantation of MfIOL: relevant difference in the quality of the retinal image may be inconvenient and require time for the difference in image to get used to.
- Neuroadaptation eventually occurs so that eventually the perceived image is clear in each eye.
- There is a concern that monocular suppression may occur
- Overall outcome may be good
- May provide for better stereopsis and spectacle independence than a monofocal IOL in some patients.

MfIOL and Neuroadaptation

- Brain receives simultaneously different images from MfIOLs
- Neuroadaptation is an acquired process correcting the visual input from what the brain has already learned.
- Adjusts the perceived image to the real-world image
- May be time-consuming
- Dependence on the type of IOL age and other aberrations.
- Younger patients adapt easier than older patients
- Most patients experience visual improvement and adapt.
- Minimum of 3 months maximum at one year.

MfIOLs and Visual Outcomes

- Uncorrected monocular visual acuity better than 20/40 in 100% papers reviewed. 70.6% monocular better than 20/30
- Refractive IOL monocular VA better than 20/25 in 57% . Diffractive IOL with UDVA better than 20/25 in 73.7%.
- Near vision: UNVA better than 20/40 in 92.6%. Monocular UNVA better than 20/25 in 38.3% Binocular UNVA better than 20/40 in 97.3% and better than 20/25 in 62.16%
- Refractive IOL with monocular UNVA better than 20/25 19.23%
- Diffractive IOL with monocular UNVA better than 20/25 in 47.3%
- Monocular and binocular intermediate vision better than 20/30 in 95 to 96%

MfIOLs and Patient Satisfaction

- Overall patient satisfaction good
- Large study with 9300 eyes implanted showed patient satisfaction 93.8% while only 1.7% dissatisfied or very dissatisfied.
- Dissatisfaction patients complain of 94.7% blurred vision, 38.2% photic phenomena:
  - Residual ametropia 65.5%
  - PCO 15.8%
  - Large pupil size 14.5%
  - Wave front anomalies 11.8%
  - 7% required IOL exchange to resolve symptoms
  - 84% were amenable to therapy with refractive surgery, spectacle, laser capsulotomy as most often used.
  - Assessing residual ametropia should be assessed properly by performing the complete defocus curve to avoid refracting solely the far or near foci of the MfIOL.

High-Tech IOLs

Alcon IQ PanOptix trifocal

Zeiss AT LISA trifocal

High-Tech IOLs

RXSight Light Adjustable Lens

Morcher Xtra Focus Pinhole aperture IOL

High-Tech IOLs

Rayner Sulcoflex IOL

FineVision IOL

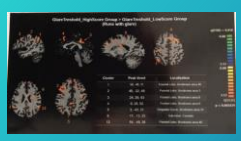
Intraoperative and Postoperative Pain in Cataract surgery

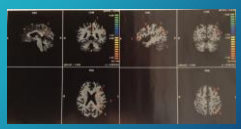
- Three factors that may predispose patients to experience more pain:
  - Eye dominance
  - Prior cataract surgery increased pain perception with lower levels of anxiety with second eye surgery. Also reported a significant reduction in patient cooperation in patients undergoing second cataract surgery
  - High myopia: pain occurring from lens-iris diaphragm retropulsion

Addressing Pain in Cataract surgery

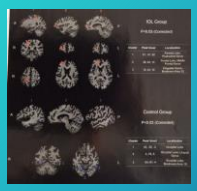
- Topical and intracameral (1%unpreserved intracameral lidocaine) anesthesia
- Benzodiazepam sedation. Reduce anxiety but not pain. Impair the patient's ability to recall pain with anterograde amnesia
- MKO Melt: formulated combination of midazolam, ketamine and ondansetron packaged as a sublingual delivery system,
- Fentanyl adjuncts to regional nerve block injections and topical anesthesia
- Topical NSAIDS
- Oral clonidine
- Regional blocks
- Omidria intracameral phenylephrine and ketorolac

Neuroadaptation MfIOL MRI Study





Neuroadaptation MfIOL MRI Study



- Functional MRI with mfIOL at 3 weeks and 6 months
- Changes found in visual cortex interpreted as an adaptation to glare
- Contrast detection thresholds decreased indicating improved contrast sensitivity
- There is recruitment of visual attention and procedural learning networks in the initial post op period
- By 6 months brain activity became a more non-effort pattern in regards to visual activation
- The regularization of the brain activity correlated with improvement in symptoms

Pediatric Ophthalmology and Strabismus

Strabismus Measurements After Dilation in Adults

- Typically performed prior to administration of dilating drop to avoid a potential change in the angle of misalignment with cycloplegia
- Adults cycloplegia is less strong as part of the exam
- Accommodation has less effects on strabismus in adults as they have decreased accommodative amplitudes compared with children
- Mean change in horizontal measurements was 0.54 prism diopters
- For vertical measurements 0.18 prism diopters
- Pupil dilation does not meaningfully affect vertical or horizontal strabismus measurements in adults
- Younger patients have mild variability and can be eliminated with +3.00 add.

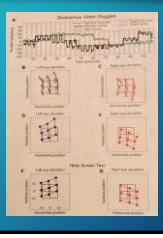
Causes of Diplopia with Epiretinal Membranes

- ERM cause distortion of the macula.
- Cause aniseikonia, metamorphopsia, decreased visual acuity
- Binocular misregistration of the retinal mosaic may cause binocular diplopia
- Known as central-peripheral rivalry type, dragged macula or macular diplopia
- Most common type of diplopia is the retinal misregistration type.
- Others caused for the diplopia may also have treatable strabismus or optical/refractive error as barrier to single vision and need to be carefully evaluated

Using Video Goggles to Measure Strabismus

- Head mounted goggles with laser for target display.
- Patient sequentially fixates laser targets on a 9-point-grid while the eyes are alternately occluded and binocularly recorded
- Compared goggles to reference standard (Hess screen test)
- Good agreement measuring horizontal and vertical deviation at 9 different gaze positions
- Goggles measured deviation in patients with visual suppression
- Simple, fast, accurate in children age 6 and above

Strabismus Goggles



Atropine for the Prevention of Myopia Progression in Children

- Level I evidence supports the use of atropine to prevent myopic progression. Evidence from most of the studies are from Asian population and may not be generalizable
- Atropine reduced myopic progression by as much as 1D/year
- Atropine 0.01% used
- Treated patients myopic progression was 0.04 to 0.47 D/year compared with untreated controls 0.38 to 1.19 D/year
- Lower dosages of atropine (0.5%,0.1% and 0.01% slightly less effective in periods 1-2 years but with less rebound myopic progression
- Rebound myopia progression after Discontinue atropine 0.01% 0.28 D/year compared with atropine 0.5% 0.87D/year
- The optimal time to initiate treatment and discontinue therapy is still unknown

Glaucoma Topics

Home Monitoring of Rapid Visual Field Progression in Glaucoma

- Researchers used simulations to quantify benefits of home monitoring for glaucoma progression
- Simulated stable and progressing glaucoma patients 2 in clinic and 3 home monitoring schedules each running over a 5 year period.
- The increased frequency of VF testing afforded by home monitoring increased the sensitivity and specificity of detecting rapid VF progression weekly; home monitoring could improve detection of rapid VF deterioration

Disinfection of Tonometer Tips

- Ophthalmic nosocomial outbreaks commonly linked to adenovirus 8 an 19 tonometer tips identified as the source
- Elimination of adenovirus is best achieved with sodium hypochlorite (1:10 dilute bleach)
- 70 isopropyl alcohol (alcohol wipes) is not sufficient to eliminate adenovirus
- HSV eliminated by sodium hypochlorite and isopropyl alcohol
- HIV and HCV no reported cases transmitted by tonometer tips but in nonophthalmic setting dilute bleach will eradicate both
- Patient s with prion disease disposable tonometer covers or single use tonometer's used.

Anti-VEGF Injections and Glaucoma

- Injection increases the volume of the eye temporarily increasing IOP
- Usually self-limited resolves in 30 to 60 minutes
- ANCHOR study 11% eyes greater than 25mm Hg compared with 5% in controls
- Diabetic Retinopathy Clinical Research Network Investigators found 9.5% compared with controls of 3.4%
- An increased rate of needing glaucoma surgery in a small number
- Most patients do not develop glaucoma or ocular hypertension
- Careful monitoring in patient with preexisting OHTN or glaucoma

Retinal Nerve Fiber Layer (RNFL) Thinning and Normal Aging

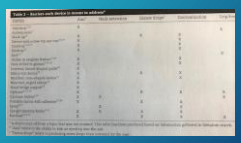
- Current definitions for detecting RNFL thinning have a poor level of specificity.
- More stringent definitions needed to avoid misinterpreting progression on OCT imaging
- For eyes followed for a short period of time a change can occur merely by chance leading to a false positive interpretation of worsening glaucoma
- Study show age-related changes in RNFL thickness average -0.54 microns per year (up to -0.92 microns per year)
- 95% of healthy eyes had changes less than -0.92 microns per year
- Authors suggest trend-based analysis of RNFL thickness change to involve testing the statistical significance of the change relative to the mean estimate of the age -related changes

Aids in Eye Drop Installation

- Patients must complete 4 major steps:
- Obtain medication
- Instill meds into eye successfully
- Instill meds at the appropriate time
- Follow routine on a daily basis
- Successful installation may be a major obstacle
- Desirable characteristics of eye drop aid:
  - Low cost
  - Easy to use
  - Reusable
  - Compatible with most eyedrop bottles

Aids in Eye Drop Installation

Aids in Eye Drop Installation



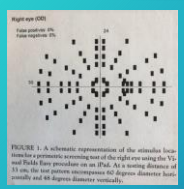
Aids in Eye Drop Installation

- Change tip color from translucent to black Apo-timop (Apotex)
- Easidrop (Quoteforce) device designed to fit into orbit
- Eyedrop (Vanguard Design)
- Eyot (Spruyt hillen, Ilsselstein)
- Inverted funnel-shaped guide (Merck Frosst Canada)
- Mirror-hat device
- Opticare (Cameron Graham Limited)
- Spray dispenser instead of drop
- Upright eye-drop bottle
- Xal-Ease

Performance of an iPad Application to Detect Visual Field Loss

- Visual Fields Easy (VFE): portable, easy fast effective procedure for detecting moderate or advanced visual field loss
- Compared with Humphrey Filed analyzer 24-2 SITA Standard
- Improvements underway to monitor eye and head tracking during testing, reduce test time, improve performance and eliminate the need to touch the video screen

VFE and Humphrey 24-2 SITA Standard

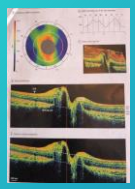


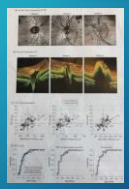
Neurophthalmology

Detection of Elevated Intracranial Pressure in Children: OCT

- Noninvasive quantitative measures of the peripapillary retina structure by SD-OCT were correlated with invasively measured intracranial measured
- Children with craniosynostosis and hydrocephalus with increased intracranial pressure studied
- OCT parameters showed promise as surrogate noninvasive measure of intracranial pressure, outperforming other conventional measures
- Spectral domain OCT of the peripapillary region has potential to advance current treatment paradigms for elevated intracranial pressure in children

Detection of Elevated Intracranial Pressure in Children





Pediatric Papilledema (PE) vs Pseudo papilledema (PPE)

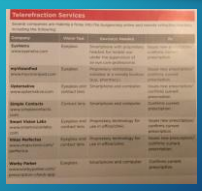
- Papilledema in children sign of meningitis or brain tumor
- Pseudo papilledema mistaken for true PE 76% of time
- Most common PPE in children is optic disc drusen (ODD)
- ODD early in life are noncalcified and buried had more likely to simulate PE B-scan ultrasonography may not be as sensitive
- ODD and PE can coexist.
- FA, B-scan US, auto fluorescence , OCT volumetric scans with RNFL analysis compared.
- FA was best and if showing leakage/no leakage then other invasive testing can be performed /avoided.

Miscellaneous Topics

Solar Eclipse 2017

- Sun's core irradiance is intense (1350 W/msq) but diffuse. If focused by eye effect is similar to damage induced by handheld lasers
- Solar retinopathy two mechanisms
  - Near infrared radiation (invisible) causes thermal injury happens without pain as retina has no pain nerve fibers
  - Visible light causing photochemical toxicity damaging RPE and choroid
- Evaluated a patient in same way as a suspected laser pointer-induced retinopathy documenting with fundus photography or OCT
- 1999 study from the UK showed that only 8.9% of patients were symptomatic after 7 months as the evidence of the injury ultimately resolves
- Eye protection with International Organization of Standardization 12312-2 filters for safe eclipse viewing

Opternative Online Eye Exam Alternative Technologies and Detecting Eye disease



Tele-refraction Services

- Consumer takes the remote vision test
- Opternative uses ophthalmologist to read test results, review medical history, provide a prescription and clinical guidance
- Opternative attempts to screen that are not good candidates.
- Inclusion criteria: 18 to 50 years;
- -10.00 to +3.50 spherical power; +0.24 to +3.00 cylinder;
- +0.25 to +4.00 add powers
- Customer must present a previous prescription
- First time contact lens wearers not serviced at this time

Tele-refraction Services

- Test time 20 minutes or less
- Charge for glasses or contact RX is $50 ($60 for both)
- ODs battling at the state level to restrict use
- Small studies have shown good agreement with office based refraction but no peer reviewed results available yet
- Opternative makes it clear that its service is not a comprehensive eye exam.
- Patients are referred to eye professional in the local data base
- Will not provide a refraction if proof of exam after 4 years is not provided
- Site recommends an exam every 2 years
- PD measurement can download a ruler and place over the bridge of nose and take photo with cell phone.
- Question of accuracy compared to optical shop pupillometer.

Smartphone in the Clinic

- Adapter to slit lamp with 10x ocular or handheld
- Photo editing apps available Google app or iTunes
- Differing methods of illumination shown in photos
- Optical image stabilization (OIS) on recent iPhone and Samsung models
- Recommended settings: white balance=on; high definition=on; anti-shake=on; picture size=4:4 3264 X 2448; flask=off; grid lines=off; storage location=memory card

IRIS Registry History and Future

- IRIS Intelligent Research in Sight Clinical Data
- Data extraction system built by AAO.
- Clinical data registry(CDR). Organized data system collects uniform data to evaluate outcomes
- Upload information from an individual EHR
- Purposes: identify processes and procedures that improve patient outcomes; promote population health; generate new scientific knowledge
- Launched in March 2014 by AAO
- Currently extracts for the calculation of 15 pertinent electronic Clinical Quality Measures

IRIS Registry

- In addition, collects data on 22 outcome measures for subspecialists
- With time can refine measures and adjust for severity of illness comorbidities
- Each participant has access to a web based dashboard and can track performance from office or home computer
- Other CDRs have shown that measurement of performance leads to rapid improvement in practice and outcomes
- In 2016 more than 11,000 providers
- Participating ophthalmologists avoided over $95 million in penalties
- American Board of Ophthalmology recognizes the IRIS Registry dashboard as self initiated practice improvement activity for maintenance of certification
- May be used for research
- As of July 2017 148 million patient visits of 37 million patients have been enrolled

Plaquenil Guidelines New Risks , New Presentations

- Daily dose should be 5.0mg/kg using real body weight
- Real body weight corrects the problem od overdosing smaller women
- Duration of medicine use: more than 5 years increases the risk, 2% risk in the first 10 years increasing to nearly 20% after 20years of use
- Kidney disease increases risk
- Tamoxifen use in breast cancer patients increase toxicity 5 fold
- Atypical presentation in Asian patients showing degeneration near the vascular arcades rather than parafoveal. Need to perform 10-2 and 24-2 VF for these patients
- Initial baseline exam within the first 5 years after 5 years, yearly screening
- Baseline VF and SD-OCT recommended

Plaquenil Toxicity New Presentation

- Pericentral Presentation
- Asian Patients
- Top SD-OCT with temporal loss of outer retina (ellipsoid zone and interdigitation zone)
- Wide field autofluorescence with hyperfluorescence inferior temporal macular
- 30-2 VF result; 10-2 VF normal

Imaging with Retina Applications

Deep Learning in Ophthalmology

- Class of machine learning artificial intelligence (AI)
- Computer models processing multiple layers of data
- Improved speech recognition, visual object recognition, object detection
- Driven by Google brain and IBM
- Ophthalmology AI: computerized analytics as a path toward more efficient and more objective ways to interpret the flood of images that modern eye practices produce
- Automated identification of diabetic retinopathy (DR)
- AI model capable of differentiating healthy fundi from DR using fundus photographs
- 94% sensitivity and 98% specificity
- Possible reliable tool for automate detection of DR. Ease of use and can be run from personal computer and smartphone

Artificial Intelligence (AI) Basics

- New computers simulating the complexity of the brain neural networks in image recognition to detect and measure pathology in eye images
- Analyze pixels in fundus photographs or 3-D voxels in OCT images
- **Simple detectors**: pattern recognition
- **Basic machine learning**: computer given what disease looks like and a training set of images from affected and unaffected eyes
- Computer examine the images to learn the differences
- **Advanced machine learning** with one or two interconnected layers of small computing units mimic the multilayered structure of the visual cortex
- The input to the first layer is fed to additional layers with the final layer coming up with the diagnosis
- **Deep learning with convolutional networks CNN** used to describe the multiple layers and the required learning

Deep Learning and AMD

- Computer-aided Diagnosis (CAD) of OCT images
- CAD has been applied to imaging studies in radiology
- CAD systems with FDA approval for lesion detection and volumetric analysis in mammography, chest radiography, chest CT
- Deep learning has revolutionized the field of computer vision
- Several convolutional layers are developed that allow for significant gains in ability classify images and detect objects in a picture
- Authors were able to apply deep learning model to distinguish AMD from normal OCT.
- First application of deep learning to OCT images

Deep Learning OCT

Deep Learning OCT

- May prove beneficial in a screening for AMD on a large scale
- May prove beneficial in providing an automated classification system for AMD and other retinal diseases using OCT imaging and large diagnostic specific data bases
- May be able to identify concerning macular OCT images and efficiently display them to the clinician to aid in the diagnosis and treatment of macular pathology as in CAD model found in radiology.

Deep Learning Diabetic Retinopathy

Defining the Role of OCT Angiography (OCTA) in Clinical Practice

- OCT angiography relies on motion contrast to identify flow in blood vessels by looking for differences in signal between repeated scan obtained at the same location
- Many disease evaluated
- Also used to characterize the normal retina and choroidal circulations
- Still in the process of evolution: new algorithms, and new capabilities being released periodically

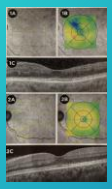
Defining the Role of OCTA in Clinical Practice

- Limitations of the technology: absence of dynamic information (flow, leakage) and the presence of numerous artifacts (motion, segmentation, signal attenuation and projection
- Limitation are challenges in interpretation as ophthalmologists need to became familiar with the appearance especially deeper circulations
- Paucity of large clinical studies to define its use since it is new technology

Defining the Role of OCT Angiography (OCTA) in Clinical Practice

- Comparing OCTA to Fluorescein angiography (FA) for CNV (wet AMD)
- Sensitivity of OCTA (eyes with CNV correctly detected) range from 50 to 100%
- Specificity (eyes without CNV correctly detected) 60 to 100%
- Structural OCT alone may sufficient to make clinical decisions and OCTA may not be a practical advantage and not be worth the extra investment
- Study shows that structural OCT highly sensitive for detecting CNV (100%)
- Structural OCT specificity less, 85 to 97%
- OCTA enhanced the specificity of structural OCT.
- Possibility that FA may not be necessary if both structural OCT and OCTA are available
- Larger studies on the way to help define precisely the optimal use of OCTA in clinical practice

Disorganization of Inner Retinal Layers (DRIL) and Diabetic Macular Edema (DME)



- Central retinal thickness is imperfect predictor of outcomes in DME
- Evaluation of intraretinal cysts, microaneurysms, subretinal fluid, external limiting membrane disruption.
- Change in the DRIL affecting at least 50% of the central 1mm central retinal zone is associated with worse VA with current or resolved edema.