What’s New and Important in Pediatric Ophthalmology and Strabismus for 2018

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1. **AMBLYOPIA**

**Effectiveness of a Binocular Video Game vs Placebo Video Game for Improving Visual Functions in Older Children, Teenagers, and Adults with Amblyopia**

This multicenter, double-masked, randomized clinical trial was The Binocular Treatment of Amblyopia Using Videogames from 3/2014 through 6/2016. This study reports 115 participants, from ages 7 to 55 years, with unilateral amblyopia (Snellen vision equivalent of 20/40-20/200) due to anisometropia, strabismus, or both. Results indicate no significant difference detected between the binocular video game treatment group and the placebo video game treatment group in the amblyopic eye visual acuity at 6 weeks. Of the participants, 65 (56.5%) were male and 83 (72.2%) were white and the mean age at randomization was 21.5 years. Compliance with more than 25% of prescribed game play was achieved by 64% of the active group and 83% in the placebo group. At 6 weeks, 36 (64%) participants in the active group achieved fellow eye contrast greater than 0.9 in the binocular video game. Adverse events reported included 3 participants with transient asthenopia, but no reported diplopia. In summary, the authors conclude that this particular dichoptic video game of falling blocks played at home on an iPod Touch for 1 hour a day for 6 weeks did not improve visual outcomes more than the placebo video game despite increases in the fellow eye contrast during the game play. The authors suggest that their results indicate that more engaging video games are needed.

**Spectral-Domain Optical Coherence Tomographic Angiography in Children With Amblyopia**

This was an observational case-control study of patients at Stein Eye Institute at UCLA from 9/1/2016 through 5/31/2017 to evaluate for retinal and microvascular features using OCTA in children < 18 years old with amblyopia. The authors reported 63 eyes evaluated, 13 (21%) with amblyopia and 50 (79%) without amblyopia (control). Of the 59 patients, the mean age of the amblyopic patient was 8.0 years old as compared to 10.3 years of the control patient. The macular vessel density of the superficial capillary plexus was lower in the amblyopic patients as
compared to the controls, in both 3x3mm and 6x6mm scans, with the 6x6mm scans being statistically significant. Macular vessel density of the deep capillary plexus in the 6x6mm was also lower in the amblyopic patients as compared to the control group. In summary, OCTA reveals a subnormal superficial and deep retinal capillary density in the macula for amblyopic patients as compared to a control group. In summary, this study shows the value of SD-OCT to detect microstructural changes in amblyopic retinas versus non-amblyopic retinas.

**Slow reading in children with anisometropic amblyopia is associated with fixation instability and increased saccades.**


Previous studies show slow reading in strabismic amblyopia. However, recently the amblyopia, not strabismus, was identified as the key factor in slow reading in children. The authors conducted this cross-sectional study in order to examine reading in anisometropic children and evaluate whether slow reading was associated with ocular motor dysfunction in children with amblyopia. Anisometropic children (7-12 years) with or without amblyopia were compared to age-similar normal controls. Children silently read a grade-appropriate paragraph during binocular viewing. Reading rate (words/min), number of forward and regressive saccades (per 100 words) and fixation duration were recorded with the ReadAlyzer. Binocular fixation instability was also evaluated (EyeLink 1000). Their results showed that amblyopic anisometropic children read more slowly (n = 25; mean with standard deviation, 149 +/- 42 words/min) than non-amblyopic anisometropic children (n = 15; 196 +/- 80 words/min; P = 0.024) and controls (n = 25; 191 +/- 65 words/min; P = 0.020). Non-amblyopic anisometropic children read at a comparable rate to controls (P = 0.81). Slow reading in amblyopic anisometropic children was correlated with increased forward saccades (r = -0.84, P < 0.001), increased regressive saccades (r = -0.85, P < 0.001), and fellow eye instability during binocular viewing (r = -0.52, P = 0.019). The authors concluded that slow reading in school-age children with anisometropic amblyopia is related to increased frequency of saccades and fixation instability of the fellow eye. The relationship of reading rate and the number of saccades is consistent with previous studies of reading in strabismic amblyopia. This is a well-designed study that highlights an oculomotor dysfunction as a possible underlying cause of slow reading in amblyopic patients. It is interesting that the authors did not find a relationship between reading rate and amblyopic eye visual acuity suggesting that the presence, not severity, of amblyopia was sufficient to cause slower reading in anisometropic children.

**A Randomized Trial of a Binocular iPad Game Versus Part-Time Patching in Children Aged 13 to 16 Years With Amblyopia**

There is emerging evidence that a binocular approach to the treatment of amblyopia can improve amblyopic eye visual acuity in adult patients with strabismic, anisometropic, and mixed-mechanism amblyopia, and possibly at a greater rate than patching treatment. To achieve a binocular precept, dichoptic displays have been used to present high-contrast images to the amblyopic eye and low-contrast images to the fellow eye in order to overcome binocular suppression commonly found in amblyopia. The purpose of this randomized clinical trial was to compare the improvement in amblyopic eye VA after 16 weeks of home-based treatment with binocular game play on an iPad device prescribed for 1 hour a day vs patching prescribed for 2 hours a day, in teenagers aged 13 to <17 years with amblyopic eye visual acuities of 20/40 to 20/200. One hundred participants aged 13 to<17 years (mean 14.3 years) with amblyopia (20/40 to 20/200, mean 20/63) resulting from strabismus, anisometropia, or both were enrolled into this randomized clinical trial. Participants were randomly assigned to treatment for 16 weeks of either a binocular iPad game prescribed for 1 hour per day (n = 40) or patching of the fellow eye prescribed for 2 hours per day (n = 60). The main outcome measure was change in amblyopic eye VA from baseline to 16 weeks. Mean amblyopic eye VA improved from baseline by 3.5 letters (2-sided 95% confidence interval [CI]: 1.3–5.7 letters) in the binocular group and by 6.5 letters (2-sided 95% CI: 4.4–8.5 letters) in the patching group. After adjusting for baseline VA, the difference between the binocular and patching groups was -2.7 letters (95% CI:-5.7 to 0.3 letters, P=0.82) or 0.5 lines, favoring patching. In the binocular group, treatment adherence data from the iPad device indicated that only 13% of participants completed>75% of prescribed treatment. The authors concurrently conducted a parallel study of binocular treatment in younger children aged 5–12 years, which showed greater VA improvement than the current study. Although this younger group also had poor adherence to treatment, they had a higher median proportion of treatment hours than the teenager group. The authors conclude that, in teenagers aged 13 to <17 years, improvement in amblyopic eye VA with the binocular iPad game used in this study was not found to be better than patching, and was possibly worse. Nevertheless, it remains unclear whether the minimal treatment response to binocular treatment was owing to poor treatment adherence or lack of treatment effect.

2. VISION SCREENING

3. REFRACTIVE ERROR

Reducing the Progression of Myopia
Atropine for the Prevention of Myopia Progression in Children: A Report by the American Academy of Ophthalmology

This is a literature review of the efficacy of topical atropine for the prevention of myopic progression in children. Literature searches were last conducted in December 2016 in the PubMed database with no date restrictions, but were limited to studies published in English, and in the Cochrane Library database without any restrictions. This resulted in 98 citations, 23 of which were reviewed in full text. Of these, 17 articles were deemed appropriate for inclusion in this assessment and subsequently were assigned a level of evidence rating by the panel methodologist. Seventeen level I, II, and III studies were identified. Most of the studies reported less myopic progression in children treated with atropine compared with various control groups. All 8 of the level I and II studies that evaluated primarily myopic progression revealed less myopic progression with atropine (myopic progression ranging from 0.04±0.63 to 0.47±0.91 diopters (D)/year) compared with control participants (myopic progression ranging from 0.38±0.39 to 1.19±2.48 D/year). In studies that evaluated myopic progression after cessation of treatment, a rebound effect was noted. Several studies evaluated the optimal dosage of atropine with regard to myopic progression, rebound after treatment cessation, and minimization of side effects. Lower dosages of atropine (0.5%, 0.1%, and 0.01%) were found to be slightly less effective during treatment periods of 1 to 2 years, but they were associated with less rebound myopic progression (for atropine 0.01%, mean myopic progression after treatment cessation of 0.28±0.33 D/year, compared with atropine 0.5%, 0.87±0.52 D/year), fewer side effects, and similar long-term results for myopic progression after the study period and rebound effect were considered. All doses of atropine studied did show reduction in accommodative ability after 2 years of treatment and 1 year of wash-out period. Studies looked at other parameters such as effect on ocular biometry, accommodation, and pupil size. Axial length elongation is reduced in atropine than control groups. In the ATOM 2 trial, there was an average accommodation reduction of -2.56 D less than that measured at baseline for all of the atropine groups (0.5%, 0.1% and 0.01%) that showed dose response. The most robust and well-designed studies were carried out in Asian populations. Studies involving patients of other ethnic backgrounds failed to provide sufficient evidence of an effect of atropine on myopic progression. Level I evidence supports the use of atropine to prevent myopic progression. Although there are reports of myopic rebound after treatment is discontinued, this seems to be minimized by using low doses (especially atropine 0.01%).

Efficacy and Adverse Effects of Atropine in Childhood Myopia: A Meta-analysis
This was a meta-analysis of 19 studies which included 3137 children in which atropine treatment was effective at slowing the progression of myopia. The authors included randomized clinical trials and cohort studies. The meta-analysis found that all doses of atropine were equally effective at slowing the progression of myopia and high doses of atropine were associated with more adverse effects, such as photophobia. Also, there was not a difference in adverse effects between Asian and white patients. In summary, the results suggest that the efficacy of atropine is dose independent and adverse side effects is dose dependent. This meta-analysis is helpful as the PEDIG (pediatric eye disease investigator group) will launch a study of dilute atropine treatment to slow the progression of myopia in children.

Development of Refractive Errors—What Can We Learn From Inherited Retinal Dystrophies?

This is a case control study of patients with known inherited retinal dystrophies (IRD) in two eye centers in the Netherlands. The reference population was the Rotterdam III population based study patients. The purpose of this study was to evaluate the refractive errors in patients with IRD. The authors explain that if the retina-to-sclera signaling cascade causes myopia, and IRDs are caused by dysfunction of a single retinal type, then looking at the affected cell type, causal gene, and refractive errors may provide insight to the causes of myopia. Distributions and mean spherical equivalents were calculated and risks of myopia and hyperopia were calculated. The retinal dystrophies were grouped into those which affect the RPE (Stargardt, Best, pattern dystrophies), cone dominated dystrophies (achromatopsia, cone-rod dystrophies), rod dominated dystrophies (retinitis pigmentosa), and bipolar cell dysfunctions (congenital stationary night blindness). The authors found that bipolar cell related dystrophies (CSNB) were associated with the highest risk of high myopia (-6D or more) (OR = 239.7) followed by cone related dystrophies (OR = 19.5). Bipolar cell related dystrophies were also associated with high hyperopia (+6D or more). Cone dystrophies and retinitis pigmentosa mostly led to mild myopia (-1.5 to -3 D). The authors concluded the bipolar cells may be important in the development of myopia. They looked further into the genes causing bipolar cell dysfunction as well as those which cause high refractive error and found significant overlap. The authors speculate that mutations in the IRD genes can cause retinal dystrophies and genetic variants may cause myopia. The authors point out that this study doesn’t prove causation, and that this is the first systemic evaluation of refractive errors in IRD. Note that this study was not done using pediatric patients, but is relevant to the pediatric ophthalmologist.

4. VISION IMPAIRMENT
Reading difficulties and the pediatric ophthalmologist.
This article is part of symposium on childhood reading difficulties. Approximately 20% of children have dyslexia, a language-based reading disability. A variation in language processing in the brain leads to a deficit in phonological (auditory) processing, which leads to problems in learning to read, write, and spell. Myths continue to exist regarding dyslexia and vision, and although eye and vision problems may coexist with dyslexia, they are not more prevalent than in the general population. Rarely vision problems may make reading at near very difficult and may masquerade as a learning problem or attention deficit disorder/attention deficit hyperactivity disorder. The pediatric ophthalmologist can play a valuable role in determining whether any eye or vision problems exist that might interfere with learning or reading. Treatments to improve these eye conditions may help make reading more comfortable, but they are not a therapy for coexisting dyslexia. The use of vision therapy has never been shown scientifically to be effective and may prevent the application of effective interventions during the critical period of development when reading disorders can best be remediated. The pediatric ophthalmologist should educate parents about reading and dyslexia and provide prompt referral to professionals who have expertise in evaluating and treating learning disabilities. This comprehensive review discusses different aspects of dyslexia, its signs and its management. Early diagnosis is emphasized for better prognosis.

Bilateral childhood visual impairment: child and parent concerns.

The purpose of this observational descriptive study was to identify specific health-related quality of life and visual function concerns affecting children with bilateral visual impairment as expressed by the children or one of their parents (proxy) and concerns affecting the parents themselves. A total of 37 children <16 years of age with visual impairment (visual acuity worse than 20/70 in the better eye) and one parent for each child were prospectively enrolled. Semi-structured individual interviews were performed with children 5-15 years of age (n = 16) and with one parent for each child (ages 0-15 years, N = 37). Interview transcripts were analyzed using NVivo software. Categories of concern were identified from both child and parent interviews, from which broad themes were identified. The frequencies of the themes and specific categories of concerns were calculated. Regarding the child's experience, categories of concern were grouped into 6 themes: visual function (expressed by 13 of 16 children [81%] and 33 of 37 parents [89%]), treatment (63% and 54%), emotions (50% and 68%), social (50% and 70%), physical discomfort (50% and 22%), and worry (38% and 8%). Concerns expressed regarding the parents' own experience were grouped into 5
themes: worry (100%), compensate-adjust for condition (89%), treatment (84%), emotions (81%), and affects family (46%). The authors conclude that individual interviews in their cohort of patients identified a wide spectrum of concerns in children with visual impairment and their parents, affecting functional, emotional, social and physical domains. These specific concerns will be used to develop patient-derived questionnaires for quantifying the effects of visual impairment on children and parents in everyday life.

A detailed description of the questions used in the interviews, patient characteristics and detailed concerns are presented in the article.

**Infant viewing of social scenes is under genetic control and is atypical in autism**


Social visual engagement is pathognomonic to impaired in autistic children. Evidence shows that autism is among the most highly heritable neuropsychiatric conditions. This study examined concordance patterns in how children visually engage in social interactions. Preferential attention and the timing, direction, and targeting of individual eye movements are strongly influenced by genetic factors. The authors found a high monozygotic twin-twin concordance in eye-tracking experiments (0.75-0.98) versus dizygotic twin-twin concordance (0.00-0.60). Monozygotic twins also have greater probability of shifting their eyes at the same moment in time and in same direction. The characteristics that are most highly inheritable, preferential attention to eye and mouth regions of the face, are decreased in children with autism (P<0.0001). According to the authors the findings underscore the notion that social visual engagement constitutes a neurodevelopmental endophenotype, for autistic children ad population-wide variation in goal-directed seeking and valuation of social information.

**5. NEURO-OPHTHALMOLOGY**

**Increased Mortality and Comorbidity Associated With Leber's Hereditary Optic Neuropathy: A Nationwide Cohort Study.**


Leber's hereditary optic neuropathy (LHON) is a mitochondrial genetic disease in which optic neuropathy is considered a key feature. Several other manifestations of LHON have been reported; however, little is known of their incidence and the life expectancy in LHON patients.

This study, based on Danish nationwide health registries, included 141 patients diagnosed with LHON and 297 unaffected family members in the maternal line.
The incidence of comorbidities and mortality for patients with LHON and unaffected family members was compared with that in the general population. Having LHON was associated with an almost 2-fold risk of mortality with a rate ratio (RR) of 1.95 (95% confidence interval [CI]: 1.47-2.59; P < 0.001). The incidence of several diseases was increased for LHON patients, but not for family members. The incidence of stroke was 5.73 per 1000 patient-years for LHON patients compared to 2.33 for the general population, and the RR was 2.38 (95% CI: 1.58-3.58; P < 0.001). The incidence of demyelinating disorders was 2.24 compared to 0.21 for the general population; RR was 12.89 (95% CI: 6.70-24.77; P < 0.001). A 4-fold risk of dementia was seen for LHON patients (RR: 4.26, 95% CI: 1.91-9.48; P < 0.001), incidence 1.45 for LHON and 0.37 for the general population. Moreover, LHON patients had an increased risk of epilepsy, atherosclerosis, nerve symptoms, neuropathy, and alcohol-related disorders. The manifestation of LHON was associated with increased mortality and increased incidence of several disorders including stroke, demyelinating disorder, dementia, and epilepsy.

**Oral fluoroquinolones and risk of secondary pseudotumor cerebri syndrome**


This is a case-control study where cases were identified in a database. These cases had received a new ICD-9 code of pseudotumor cerebri syndrome after receiving a prescription for a fluoroquinolone. Also required for cases were CPT codes for an MRI or CT of the brain and lumbar puncture within 15 days of the ICD-9 code for pseudotumor cerebri syndrome. Ten controls were chosen for each case that were matched by age, sex, etc. The authors found an increased risk of pseudotumor cerebri syndrome in patients who received fluoroquinolones with a relative risk of 5.62 for patients receiving fluoroquinolones within 15 days, and 4.02 for within 30 days. The authors estimate that approximately 30% of cases of pseudotumor cerebri syndrome may be attributed to fluoroquinolone use. One weakness of this study is its dependence upon diagnostic codes. A strength is its large sample size.

**Childhood-onset Leber hereditary optic neuropathy**


Leber hereditary optic neuropathy (LHON) is a mitochondrial disorder causing acute or subacute loss of vision in young men, with peak onset of visual loss at 20-30 years of age. Childhood onset is rare, with less than 10% of patients diagnosed at age 12 or younger. This study aimed to describe the clinical and genetic characteristics of childhood onset LHON in a UK cohort of 27 patients as well as
69 patients from a literature review. The two groups had similar clinical and molecular profiles, so their data was combined. The authors found that the childhood cohort had comparable distributions of the three major LHON mutations. The male to female ratio (1.8) was less than that seen in adults. Acute pattern of vision loss was the most common presentation, although over a third had slow or subclinical onset. The insidious/subclinical group did occur with all three major mtDNA mutations. Rates of spontaneous visual recovery were similar to that of adults, and was more common in certain mutations, with those having the m.3460G>A mutation having a better visual prognosis. Overall 39% of patients achieved BCVA ≥ 0.5 in at least one eye, and 19% had BCVA <0.05 in their better eye. The authors conclude that the childhood onset cohort had a more varied clinical evolution and favorable visual prognosis than classical adult LHON, and that children do not always have an acute or subacute presentation.

Diagnostic algorithm for relapsing acquired demyelinating syndromes in children

This article proposes an algorithm for classifying the pediatric relapsing demyelinating syndromes, multiple sclerosis (MS) and neuromyelitis spectrum disorder (NMO-SD). 110 children with relapsing demyelination were included. A panel diagnosed 56% with MS, 25% with NMO-SD, 13% with multiphasic disseminated encephalomyelitis, and 6% with recurrent optic neuritis. The authors propose that first an MRI brain and spine should be performed, and if the findings are typical or suggestive of MS, to apply the McDonald diagnostic criteria. If not typical or suggestive of MS, but the MRI and clinical findings are more suggestive of NMOSD, aquaporin-4 antibodies should be performed. In AQP-4 negative cases, MOG antibody should be tested. If the MRI is not typical for MS or NMOSD, but suggestive of ADEM, MOG antibody should be tested. The remaining cases are antibody negative relapsing demyelinating syndromes if other diseases are eliminated as possibilities. Overall 83% of the patients with non-MS relapsing demyelinating syndrome had an antibody associated disease. The authors suggest in the next set of diagnostic criteria that anti-MOG antibody disease be included as a distinct entity from other relapsing demyelinating syndromes.

Evaluation of Optical Coherence Tomography to Detect Elevated Intracranial Pressure in Children

The authors evaluated the peripapillary retina from spectral domain optical coherence tomography (SD-OCT) in 79 children with elevated intracranial pressure to determine if retinal measurements could be an effective surrogate for invasive intracranial pressure measurement. From 2014 to 2015, the cross-sectional
study included three cohorts: patients with craniosynostosis, a positive control cohort of patients with hydrocephalus, and a negative control cohort of healthy patients undergoing minor procedures. In summary, noninvasive measurements of the peripapillary retina by SD-OCT were correlated with invasively measured intracranial pressure. In this way, SD-OCT measurements show promise as a noninvasive surrogate to measure intracranial pressure in children, especially children under 5 years old.

6. Nystagmus

Magnetic Oculomotor Prosthetics for Acquired Nystagmus

The authors have devised a novel magnetic prosthesis to dampen the oscillation in acquired nystagmus patients. Acquired nystagmus is often resistant to pharmacotherapy. Although heterogeneous in its neural cause, its expression is unified at the effector—the eye muscles themselves—where physical damping of the oscillation offers an alternative approach. Because direct surgical fixation would immobilize the globe, action at a distance is required to dampen the oscillation at the point of fixation, allowing unhindered gaze shifts at other times. The device is a 2-part, titanium-encased, rare-earth magnet powered to dampen nystagmus without interfering with the larger forces involved in saccade. Implementing this idea magnetically allows for unhindered gaze shifts at other times. A 49-year-old man with longstanding, medication-resistant, upbeat nystagmus resulting from a paraneoplastic syndrome caused by stage 2A, grade I, nodular sclerosing Hodgkin’s lymphoma requested for a novel therapy and underwent this procedure. The smaller magnet (the ocular component) was sutured to the undersurface of the inferior rectus, centered approximately 10 mm behind the muscle insertion. The larger magnet was placed alongside the ocular magnet, and the eye was aligned to primary position, allowing an estimate for the optimal position of the orbital magnet; this position was maintained while medical-grade cyanoacrylate glue was run into the gap between the orbital floor and magnet base. Outcomes evaluated include comparing visual functions and high-resolution oculography before and after implantation and monitoring the patient for more than 4 years after surgery. The patient reported a clinically significant improvement of 1 line of Snellen acuity (from 6/9 bilaterally to 6/6 on the left and 6/5-2 on the right), reflecting an objectively measured reduction in the amplitude, drift velocity, frequency, and intensity of the nystagmus. These improvements were maintained throughout a follow-up of 4 years and enabled him to return to paid employment. This work opens a new field of implantable therapeutic devices—oculomotor prosthetics—designed to modify eye movements dynamically by physical means in cases where a purely neural approach is ineffective.

7. PREMATURITY.
Optical Coherence Tomography Angiography of the Fovea in Children Born Preterm


This cross-sectional observational comparative case series compared the foveal avascular zone (FAZ) area measured by OCT angiography in children born preterm to age-matched controls. 43 eyes of 26 children (28 eyes of 15 former preterm infants and 15 eyes of 11 former term infants) between the ages of 4 and 12 years old were included. OCT angiography with a scan size 3 x 3 was performed for all eyes, FAZ area was measured, and inner and outer retinal thicknesses were measured. A distinct FAZ was absent in 12 eyes (42.8%) of preterm children but was present in 100% of control eyes. The FAZ area was significantly correlated with gestational age and birth weight. The GA was less than 29 weeks and birth weight less than 1,480 grams in eyes with no distinct FAZ. Mean central foveal vessel density in the superficial capillary plexus was 41.8% in the preterm group and 32.8% in the control group. In all eyes, a negative correlation was found between the central foveal density and GA and birth weight. On SD-OCT examination, the foveal depression was absent and the inner retinal layers were preserved in all eyes with absent FAZ. In all eyes, a significant negative correlation was found between the inner retinal thickness and GA and BW. 10 eyes of 6 preterm children had a history of laser therapy for ROP. A distinct FAZ was absent in 6 eyes (60%) with ROP with history of laser, and 6 eyes (33.3%) with preterm birth without laser therapy. Eyes with a history of laser had a higher inner retinal thickness and central foveal vessel density and smaller FAZ compared to eyes with preterm birth without laser therapy.

This study had a small sample size and limited age range at the time of OCTA imaging. However, the identification of an abnormal web-like foveal microvasculature comprising the FAZ in eyes with history of preterm birth is novel. This study expands knowledge of foveal abnormalities in ROP, and confirms that a small or absent FAZ seems to be a distinct sign of prematurity.

8. ROP

ROP and Telemedicine/Screening

Validation of WINROP for detecting retinopathy of prematurity in a North American cohort of preterm infants.
WINROP (weight, insulin-like growth factor 1, neonatal, and retinopathy of prematurity) is a web-based retinopathy of prematurity (ROP) risk algorithm that uses postnatal weight gain as a surrogate of insulin-like growth factor-1 (IGF-1) to predict the risk of severe ROP in premature infants. The purpose of this retrospective study was to validate the web-based algorithm WINROP in detecting severe (type 1 or type 2) ROP in a cohort of infants from two centers in Colorado. The records of consecutive infants who underwent ROP examinations between 2008 and 2011 were reviewed retrospectively. Infants were classified into categories of "alarm" (at risk for developing severe ROP) and "no alarm" (minimal risk for severe ROP). Excluded were infants, who did not meet the inclusion criteria for the WINROP algorithm: (1) gestational age at delivery >32 weeks’ gestation, (2) missing weekly weight measurements, and (3) a weight gain of more than 450 g per week. Out of a total of 563 infants only 483 met the WINROP criteria and were included in the study. Alarm occurred in 241 neonates (50%), with the median time from birth to alarm of 2 weeks. The authors found that WINROP had a sensitivity of 81.8% (95% CI, 67.3%-91.8%) and specificity of 53.3% (95% CI, 48.5%-58.0%) for identifying infants with severe ROP. Eight of the 44 infants with severe ROP were not detected (5 with type 1 and 3 with type 2). Of these 8 infants, 7 (88%) had birth weight in excess of the 70th percentile. With additional weight data entry, sensitivity of WINROP rose to 88.6%. The authors conclude that very preterm infants (gestational age of ≤27 weeks) with relatively high birth weight for gestational age may not be detected by WINROP as high risk for developing severe ROP.

The low specificity of the current screening protocol for ROP has prompted many groups to investigate other screening algorithms for ROP. This is yet another study trying to validate the suggested alternatives to the current national screening criteria. The article includes a nice summary of previous validation studies of this algorithm.

Intraocular Hemorrhages and Retinopathy of Prematurity in the Telemedicine Approaches to Evaluating Acute-Phase Retinopathy of Prematurity (e-ROP) Study.


In this study, the authors evaluated whether clinical characteristics of intraocular hemorrhage (IOH) can potentially be used for prediction of disease severity and to improve sensitivity of a telemedicine system to detect referral-warranted retinopathy of prematurity (RW-ROP). RW ROP is defined as presence of zone I ROP, stage 3 ROP or plus disease. However early stage 3 retinopathy (especially in zone I) and evolving plus disease may be difficult to detect with certainty.
and the exact border between zone I and zone II can be difficult to capture with photos. However, IOH is easier to detect and recognize in photos. For that reason, this study describes the clinical characteristics of IOHs in infants to evaluate their potential use for prediction of disease severity. Preterm infants with birth weight (BW) ≤1250 g underwent serial digital retinal imaging in both eyes starting at 32 weeks' postmenstrual age. Non-physician trained readers (TRs) evaluated all image sets from eyes that ever had IOHs documented on image evaluation or eye examination for the presence, location, type, area, and relation of the IOH to the junction between vascularized and avascular retina. Associations of IOH with demographic and neonatal factors, and with the presence and severity of retinopathy of prematurity (ROP) were investigated by univariate and multivariate analyses. Sensitivity and specificity of identifying RW-ROP were calculated with and without incorporating hemorrhage into the standardized grading protocol. Among 1239 infants (mean [standard deviation] BW = 864 [212] g; gestational age [GA] = 27 [2.2] weeks) who underwent an average of 3.2 imaging sessions, 22% had an IOH in an eye on at least 1 of the e-ROP visits. Classification of IOH was preretinal (57%), blot (57%), dot (38%), flame-shaped (16%), and vitreous (8%); most IOHs were unilateral (70%). The IOH resolved in 35% of eyes by the next imaging session and in the majority (76%) of cases by 8 weeks after initial detection. Presence of IOH was inversely associated with BW and GA and significantly associated (P < 0.0001) with the presence and severity of ROP (BW and GA adjusted odds ratios [ORs] of 2.46 for any ROP, 2.88 for stage 3, and 3.19 for RW-ROP). Incorporating IOH into the grading protocol minimally altered the sensitivity of the system (94% vs. 95%). Approximately 1 in 5 preterm infants examined had IOHs, generally unilateral. The presence of hemorrhage was directly correlated with both presence and severity of ROP and inversely correlated with BW and GA, although including hemorrhage in the grading algorithm only minimally improved the sensitivity of the telemedicine system to detect RW-ROP.

ROP and Anti-Vascular Endothelial Growth Factor Treatment

Assessment of Lower Doses of Intravitreous Bevacizumab for Retinopathy of Prematurity: A Phase 1 Dosing Study.

Intravitreous bevacizumab (0.25 to 0.625 mg) is increasingly used to treat type 1 retinopathy of prematurity (ROP), but there remain concerns about systemic toxicity. A much lower dose may be effective while reducing systemic risk. Between May 2015 and September 2016, 61 premature infants with type 1 ROP in 1 or both eyes were enrolled in a masked, multicenter, phase 1 dose de-escalation study. One eye of 10 to 14 infants received 0.25 mg of intravitreous bevacizumab. If successful, the dose was reduced for the next group of infants
(to 0.125 mg, then 0.063 mg, and finally 0.031 mg). Diluted bevacizumab was delivered using 300 µL syringes with 5/16-inch, 30-gauge fixed needles. Success was defined as improvement in preinjection plus disease or zone I stage 3 ROP by 5 days after injection or sooner, and no recurrence of type 1 ROP or severe neovascularization requiring additional treatment within 4 weeks. Fifty-eight of 61 enrolled infants had 4-week outcomes completed; mean birth weight was 709 g and mean gestational age was 24.9 weeks. Success was achieved in 11 of 11 eyes at 0.25 mg, 14 of 14 eyes at 0.125 mg, 21 of 24 eyes at 0.063 mg, and 9 of 9 eyes at 0.031 mg. A dose of bevacizumab as low as 0.031 mg was effective in 9 of 9 eyes in this phase 1 study and warrants further investigation. Identifying a lower effective dose of bevacizumab may reduce the risk for neurodevelopmental disability or detrimental effects on other organs.

Follow-up to Age 4 Years of Treatment of Type 1 Retinopathy of Prematurity Intravitreal Bevacizumab Injection versus Laser: Fluorescein Angiographic Findings.

This is a single-center, randomized controlled trial looking at the structural outcome at age 4 years of eyes treated with intravitreal injection of bevacizumab (IVB) with fellow eyes treated with conventional laser photoablation in type 1 ROP. The study was conducted at the Catholic University in Rome, from September 1, 2009, to March 31, 2012.. Structural outcome at age 4 years was assessed using fluorescein angiography (FA). In each of 21 infants (42 eyes), 1 eye was randomized to receive an intravitreal injection of 0.5 mg bevacizumab; the fellow eye underwent conventional laser photoablation. Digital retinal imaging and FA were performed at an average of 4 years after treatment in follow-up after these studies performed at treatment and 9 months. FAs were examined by 2 experts to document retinal and choroidal findings. Among the 20 IVB-treated eyes available at 4 years of age, all showed abnormalities at the periphery (avascular area, vessel leakage, shunts, abnormal vessel branching, and tanggles) or the posterior pole (hyperfluorescent lesions, absence of foveal avascular zone). These lesions were not observed in the majority of the laser-treated eyes. Among the 19 laser-treated eyes, leakage was noted in 1 eye, shunts and tanggles were noted in 3 eyes, and macular abnormalities were noted in 3 eyes. The authors concluded that FA has shown potentially serious and long-term ocular effects that are present more commonly after treatment with bevacizumab for acute-phase ROP than after laser.

9. STRABISMUS

The role of imaging in strabismus
The authors discuss a review of the use of imaging in evaluating the EOMs in particular for the purposes of surgical planning. MRI can be useful to evaluate the function of a muscle as well as its thickness with respect to inflammation. In addition, the location of pulleys has been found to be relatively consistent across individuals so that MRI can identify misplacement of pulleys which may cause redirection of EOM force. MRI may also help to differentiate conditions such as sagging eye and heavy eye syndrome which clinically may appear similar but on imaging have different angles between the superior and lateral rectus that are diagnostic. This modality has also revealed that muscle contraction may be compartmentalized and that normal ocular motility may involve muscles thought uninvolved due to the compartmentalized contraction and action of those muscles. This may explain the variance in motility within similar types of strabismus. MRI is limited however by the lack of established protocols for more sensitive analysis of the above, which may vary by institution and at this time are largely unavailable to most clinicians. UBM can detect the muscle insertions which may be useful for surgical planning in reoperations but its accuracy declines with distance from the limbus and therefore this may limit its use. Wide field UBM has the ability to scan larger areas and thus may be a better modality for direct ultrasound measurement of the insertion. Lastly, anterior segment OCT has the advantage of being non-contact, readily obtained in the office and easier to get on younger patients. AS-OCT measurements were shown to capture muscle insertions as far back as 13.5 mm from the limbus although does not have as large a field as wide-field UBM. AS-OCT may be a useful tool for planning re-operations especially in young patients.

**Accuracy of Optical Coherence Tomography Measurements of Rectus Muscle Insertions in Adult Patients Undergoing Strabismus Surgery.**

Prior strabismus surgery can make locating the insertion of the muscle quite difficult. Pediatric ophthalmologists have looked for multiple ways to preoperatively determine where the muscles are located. This paper aimed to assess the accuracy of anterior segment optical coherence tomography (AS-OCT) in measuring the distance of the extraocular muscle insertion from the limbus. The authors performed a reliability analysis using 74 adults scheduled for strabismus surgery. They used AS-OCT to measure the distance from the limbus to the muscle insertion. The position of the muscle was then measured intraoperatively and success was defined as 1mm or less difference between the AS-OCT measurement and the intraoperative measurement. 144 muscles were analyzed in the data set and 31 of the 33 reoperated muscles were successfully imaged by AS-OCT. AS-
OCT measurements were accurate in 77% of all muscles. In the eyes without previous surgery, 83% of the muscles were accurately identified and among those with previous strabismus surgery thus number dropped to 58%. However if you changed the definition of success rates to within 2mm of the surgical measurements, then this goes up to 93.5% (29/31 eyes). There are three previous studies, but only 2/3 included muscles that previously had surgery. The authors conclude that AS-OCT can be a powerful tool in my patients with previous strabismus, but its accuracy is limited in patients with reoperation.

Strabismus – Childhood XT and ET

Relationship among clinical factors in childhood intermittent exotropia

Intermittent exotropia (IXT) patients are treated using surgical interventions and nonsurgical interventions, such as part-time occlusion, fusional vergence exercises, and over minus lenses. Nevertheless, the relative effectiveness of such treatments has not been rigorously studied, and the natural history of IXT is unknown. The authors are attempting to address some of these issues through two randomized clinical trials—one comparing part-time patching to observation, continuing with a natural history component, and a second study evaluating the effectiveness of bilateral lateral rectus recession versus monocular unilateral lateral rectus recession with medial rectus resection for the treatment of IXT. The goal of this preliminary study was to determine the relationships between stereoacuity, control of exotropia, and angle of deviation in children with intermittent exotropia (IXT). Data collected for 652 participants 3 to <11 years of age with IXT meeting eligibility criteria for enrollment into one of the aforementioned clinical trials, were used to evaluate relationships between stereoacuity, control, and angle of deviation at enrollment. Any level of stereoacuity and angle of deviation could be accompanied by any level of control. Worse distance exotropia control was weakly associated with poorer distance stereoacuity (R = 0.26; 99% CI, 0.17-0.36) and larger angles of deviation at distance (R = 0.27; 99% CI, 0.17-0.36). Worse near exotropia control was weakly associated with poorer near stereoacuity (R = 0.17; 99% CI, 0.07-0.27) and moderately associated with larger angles of deviation at near (R = 0.37; 99% CI, 0.28-0.45). There was no association between stereoacuity and angle of deviation at distance (R = 0.07; 99% CI, -0.03 to 0.17) or at near (R = 0.02; 99% CI, -0.08 to 0.12). However, the odds of being monofixational at distance, compared with being bifoveal, were greater when distance con-
trol was worse (OR 5 1.49; 99% CI, 1.24-1.80). A similar relationship was observed at near (OR 5 1.42; 99% CI, 1.16-1.73). Some limitations with the measurement of some of the parameters (Only a single measurement of exodeviation control was obtained at each fixation distance) were acknowledged. The authors conclude that weak and moderate associations were found between stereoacuity, control, and angle of deviation; a child may exhibit any combination of stereoacuity, control, and angle of deviation. The specific roles of control, stereoacuity, and angle of deviation in the diagnosis, management, and pathogenesis of IXT are unclear, and each appears to yield somewhat independent information.

Strabismus Measurements with Novel Video Goggles.

In this report, the authors describe a novel portable strabismus video goggle to measure strabismus. They assessed its performance compared to the standard Hess screen test. The authors studied 41 adults and children aged ≥ 6 years with ocular misalignment due to congenital or acquired paralytic or comitant strabismus and 17 healthy volunteers. All participants underwent measurement using the video goggles and a Hess screen test with ocular deviation measured on a 9-point target grid located at 0±15° horizontal and vertical eccentricity. The goggle has a head-fixed laser target display and LCD shutters for binocular dissociation. Each LCD shutter occlusion was 2 seconds long and 3 cycles of alternate eye occlusion were performed at each gaze position. The data from eye movement recording was then displayed in the same format as the Hess test. Agreement between the two tests was quantified using the intraclass correlation coefficient (ICC). Secondary outcomes were the utility of the goggles in patients with visual suppression and in children. There was good agreement between the strabismus video goggles and the Hess screen test in the measurements of horizontal and vertical deviation (ICC horizontal 0.83, 95% confidence interval [0.77, 0.88], vertical 0.76, 95% confidence interval [0.68, 0.82]). Both methods reproduced the characteristic strabismus patterns in the 9-point grid. The new device is simple, fast (recording time of about 2 minutes) and accurate in measuring ocular deviations, and the results are closely correlated with those obtained using the conventional Hess screen test. It can even be used in patients with visual suppression who are not suitable for the Hess screen test. The youngest patient tested in this study was 6 years of age.

10. STRABISMUS SURGERY

Horizontal muscle surgeries

Wright central plication is a minimally invasive tightening procedure described for the first time by Wright and colleagues in 2012. The purpose of this retrospective study was to compare outcomes of lateral rectus central plication (LRCP) to medial rectus recession (MRR) in the treatment of adult divergence insufficiency esotropia (ADIE). ADIE also called sagging eye syndrome was defined as esotropia (ET) that is at least 10 PD greater at distance than at near. A retrospective chart review of 30 consecutive patients with ADIE, who underwent either LRCP or MRR between 2010 and 2015 was performed. Inclusion criteria included age ≥45 years, LRCP or MRR surgery fixed suture technique, esotropia (ET) at least 10Δ greater at distance than at near, subjective diplopia at distance, fusion at near fixation, follow-up of at least 6 months. Primary outcome was postoperative single binocular vision. Secondary outcome was postoperative deviation of <5 PD. A total of 28 patients (15 females) met inclusion criteria: 15 had LRCP and 13 MRR. Both groups were quite similar by several parameters including, age (mean age ±SD was 68.92±8.07 years in the central plication group versus 64.38 ±12.33 years in the recession group [P =0.26]). Primary outcome of no diplopia was not significantly different between LRCP and MRR group having a success rate of 93.3% versus 92.3%, respectively (P ≤ 0.01). Secondary outcome of a deviation of ≤5 PD at distance was better in the LRCP group than the MRR group (15/15 vs 11/13 [P ≥ 0.01]). One patient in LRCP group had an early overcorrection corrected by in-office suture lysis. The authors conclude that both procedures had excellent primary outcomes eliminating diplopia in over 90% of cases. The LRCP group had statistically better postoperative alignment of <5 PD. The authors claim that The Wright LRCP has the advantage of being minimally invasive, semi-reversible, vessel sparing, and can be done with topical anesthesia. The study introduces the LRCP as another option for alleviating distance diplopia with patients with age-related divergence insufficiency. It has its obvious limitations, including its retrospective nature and small sample size.

Intraoperative Findings in Consecutive Exotropia with and without Adduction Deficit.

Consecutive exotropia has a reported incidence of up to 27% with long-term follow-up. Consecutive exotropia may be associated with limited adduction, which has been reported to be caused by 1 or more anatomic abnormalities of rectus muscles or their insertions. The authors studied the relative frequency of grades of adduction deficit and the relative frequency of abnormal anatomic findings.
They conducted a retrospective review of patients undergoing surgery for consecutive exotropia of ≥10 PD, excluding paralytic or restrictive strabismus. Study period was between 1995 and 2016. All surgeries were performed by a single surgeon (J.M.H). Preoperative duction deficits were graded on a -5 (severe limitation) to 0 (normal) scale. Operative reports were reviewed to classify intraoperative factors: (1) medial rectus muscle attachment type (normal, abnormal [slipped or stretched scar], attached to pulley, behind pulley, or mixed [a tenuous normal attachment, but with muscle fibers also attached to the pulley or behind the pulley]), (2) medial rectus muscle distal fiber location (millimeters from original insertion), and (3) lateral rectus muscle tightness (normal, mild restriction, moderate restriction). The authors evaluated the relationship of graded adduction deficit to each intraoperative factor. Of the 143 eyes, 124 (87%) had an adduction deficit. Eyes with abnormal (n = 23), pulley (n = 9), behind pulley (n = 8), or mixed (n = 7) attachments had worse adduction deficits than normal attachments (n = 96; P < 0.02). There was a significant correlation between distal medial rectus muscle fiber location (0-19.5 mm recessed) and grade of adduction deficit (P < 0.0001). Eyes with mild or moderate lateral rectus muscle tightness on forced duction testing (n = 48/143 eyes) had worse adduction deficits than eyes without tightness (P < 0.001). Nevertheless, despite overall correlation, there was considerable individual variability. For example, for -1 and -2 adduction deficits, medial rectus muscle attachment could be at the pulley, behind the pulley, or include the pulley (19/87 eyes [22%]), and the lateral rectus muscle was tight in 36 of 87 eyes (41%). The authors concluded that adduction deficits are common in patients with consecutive exotropia. Overall, more severe preoperative adduction deficits are associated with medial rectus muscle insertion abnormalities and abnormal forced ductions, but frequently there are exceptions. Severe medial rectus muscle insertion abnormalities, including lost muscles, may be found despite mild preoperative adduction deficits. Hence, these findings suggest that severity of preoperative adduction deficit is a poor predictor of the medial rectus muscle attachment type and the location of the distal end of the medial rectus muscle fibers, especially in patients with mild to moderate deficits of adduction. The authors recommended that surgeons need to be prepared for any combination of medial rectus muscle and lateral rectus muscle findings. They also recommend addressing any lateral rectus muscle tightness at the time of the surgery in addition to advancing or resecting the medial rectus muscle.

Comparison of Botulinum Toxin With Surgery for the Treatment of Acute-Onset Comitant Esotropia in Children.

Acute comitant esotropia is currently treated with strabismus surgery, however there are multiple drawbacks to the surgery including more time with disturbed binocularity and longer general anesthesia. Botulinum toxin is an alternative treatment for this condition, but has not been compared to standard surgery for the treatment of strabismus in acute onset comitant esotropia in the pediatric pa-
tient. The authors sought to determine if Botulinum toxin is as effective of a treatment as strabismus surgery in acute onset comitant esotropia. A retrospective study of 16 patients who were treated with the chemodenervation and 33 patients were treated with strabismus surgery was performed. The authors defined success as a total horizontal deviation of 10 prism diopters or less and evidence of binocular single vision. Success rates were not statistically different at 6 or 18 months after follow up with 13/16 (81%) of patients in the chemodenervation and 20/33 (61%) of patients in the surgery group achieving surgical success at 6 months. Additionally, the total OR time was shorter and the overall cost was lower in the patients who had the Botulinum injections. The authors concluded that the chemodenervation was not inferior to strabismus surgery for acute onset comitant esotropia in children. The authors acknowledged the surprisingly low surgical rate of success in this study. Additionally they hypothesized that the lack of delay in treatment in the chemodenervation group could have contributed to the success in this group. The limitations of the study being the retrospective nature, small number of patients due to this being a rare condition were highlighted in the paper’s discussion. The authors concluded that botulium toxin was as effective as strabismus surgery in the treatment of acute comitant esotropia in children and should be considered an alternative to strabismus surgery in this condition.

**Vertical muscle surgeries**

Anterior and nasal transposition of inferior oblique muscle in cases of superior oblique palsy.

The purpose of this small retrospective case series was to report long-term outcome of inferior oblique anterior and nasal transposition in superior oblique palsy. The medical records of patients with superior oblique palsy who underwent inferior oblique anterior nasal transposition were reviewed retrospectively. One-year postoperative results were evaluated for alignment in primary gaze, contralateral gaze, and upgaze; reduction in inferior oblique overaction and changes in fundus torsion to assess long-term outcome of the procedure. A total of 12 patients were included. Three cases also underwent horizontal muscle surgery. Mean age at the time of surgery was 20.6 ±4.1 years. The median preoperative hypertropia was 21.5 PD (range, 12-36 PD), corrected to 4.5 PD (range, 2-10 PD) at 12 months postoperatively (P = 0.002). Median inferior oblique overaction decreased from +3 (range, +1 to +4) to 0 (range, -1 to +1). Preoperative fundus extorsion was 19.2 degrees ±6.7 degrees; postoperative, 0.58 degrees ±1.8 degrees (P < 0.001). No consecutive hypotropia or underaction in elevation was observed in 10/12 patients; 1 patient complained of torsional diplopia in upgaze. Extorsion was eliminated and head tilt improved in all patients. The
authors conclude that inferior oblique anterior and nasal transposition resulted in good long-term outcomes in their cohort of patients with superior oblique palsy presenting with hypertropia, inferior oblique overaction, and extorsion in primary gaze. However, the study is limited by its small sample size and its retrospective nature. There are several surgical modalities that are suitable for this clinical situation; This study demonstrates that inferior oblique anterior and nasal transposition may be considered for managing superior oblique palsy with significant torsion.

Graded versus ungraded inferior oblique anterior transposition in patients with asymmetric dissociated vertical deviation.

The purpose of this randomized trial was to compare the surgical outcomes of graded versus ungraded IOAT in the treatment of patients with asymmetric DVD and bilateral inferior oblique overaction (IOOA). A total of 74 eyes of 37 patients with asymmetric DVD (interocular difference of ≥5 PD) and bilateral IOOA of > +1 were included in this randomized clinical trial. In the ungraded group (n = 18), both inferior oblique muscles were sutured at the inferior rectus level; in the graded group (n = 19), the inferior oblique muscles of eyes with more DVD were sutured at the level of the inferior rectus and inferior oblique muscles of eyes with less DVD were sutured 2 mm posterior to the level of the inferior rectus muscle. DVD was significantly reduced in each group (P < 0.001 for both). Although the postoperative mean difference of asymmetry of DVD was less in the ungraded group compared to the graded group (1.2 ±1.9 vs 3.2 ±1.2 [P = 0.001]), the absolute amounts of reduction of DVD asymmetry were similar (4.3 ±2.3 vs 4.4 ±3.1 [P = 0.78]). IOOA and V patterns were also reduced postoperatively. The authors conclude that both methods of IOAT were effective in reducing DVD, DVD asymmetry, IOOA, and V patterns. Although there are some limitations attributable to a difference in the groups’ baseline characteristics, with less preoperative DVD asymmetry in the ungraded group compared to the graded IOAT, this randomized study clarified this debatable subject to some extent. The report includes a detailed review on what has been published on the subject that is worth reading.

Adjustable Bilateral Superior Oblique Tendon Advancement for Bilateral Fourth Nerve Palsy.

Bilateral fourth nerve palsy can present with or without a vertical deviation, depending on the symmetry of the palsy. A torsional deviation can also exist. There are multiple surgical options for symmetric cases that present with purely torsional components and there are also multiple techniques for asymmetric cas-
es to adjust both the torsion and the vertical deviation. In this study the authors report 15 cases with bilateral superior oblique palsies who had bilateral superior oblique tendon advancement on adjustable sutures to evaluate the utility of this surgical technique. This was a retrospective interventional case series of 15 patients with either symmetric or asymmetric bilateral fourth nerve palsies aged 17-73. Eleven patients had symmetric palsy with less than 2 prism diopters of vertical deviation in primary gaze and 4 patients had asymmetric palsies. Patients were evaluated preoperatively, pre- and post-adjustment, and also 6 weeks postoperatively. The patients were marked at the 12 and 6 o'clock positions and then adjusted with a goal of 10 degrees of incyclotropia. Surgical procedure is described in detail in this paper and the adjustment was done 2-8 hours after surgery. 80% of patients needed adjustment in order to achieve the target alignment. At 6 weeks post operatively there was a mean excyclotorsion of 4 degrees with 13 patients having 5 degrees or less of torsion. Fourteen of the 15 patients had 2 prism diopters or less of hypertropia. The authors concluded that adjustable bilateral superior oblique tendon advancement allows for independent control of adjusting the torsional and vertical components of the deviation in bilateral fourth nerve palsies. This paper is limited by the small number of patients and limited follow up time.

Sutures / Adjustables

Strabismus surgery - Misc

Reduced surgical success rate of rectus muscle plication compared to resection.
Alkharashi, M. and D. G. Hunter JAAPPOS June 2017; 21(3): 201-204.

This retrospective study evaluated the surgical success of rectus muscle plication compared to resection and compared the short- and long-term changes in ocular alignment after both procedures. The medical records of all patients, who underwent a rectus muscle tightening procedure (resection or plication) at a single institution over a 5-year period by a single surgeon were reviewed retrospectively. Binocular alignment was recorded before and immediately after surgery and again at 6-12 weeks and final follow-up visit. Primary outcome was surgical success rate, defined as distance alignment of less or equal to 10 PD for horizontal and less or equal to 6 PD for vertical strabismus. Secondary outcomes were reoperation rate and postoperative alignment drift. A total of 72 surgeries were identified for inclusion: 48 resections and 24 plications. Surgical success was significantly higher in the resection group than in the plication group (89% vs 58%; P = 0.005) at both 6-12 weeks' follow-up (P = 0.005) and at mean final follow-up of 19 ± 13 months (range, 3-56 months [n = 48]; P = 0.03). Reoperations were performed in 3 patients in the plication group (12.5%), all for undercorrec-
tion; there were no reoperations in the resection group (P = 0.03). The authors conclude that despite the potential advantages of rectus muscle plication over resection, in their experience, patients treated with plication had lower surgical success rates and a higher reoperation rate. They suggested that surgeons should monitor their long-term results before considering plication as their procedure of choice over resection.

The technique used in this study is not comparable to previous more favorable reports on plications. This study is limited by its retrospective nature, which may have biased patient selection. Both groups are very diverse and statistically different by age. The plication group was older and that may have also affected the results.

The resurgence of botulinum toxin injection for strabismus in children


The authors present a review of the use of botulinum toxin (BT) in strabismus. Advantages to the use of BT include decreased anesthesia time and postoperative care unit time, decreased risk of overcorrection once it has worn off (within 3-6 months of injection), and preservation of muscle tissue for possible further surgery in the future, although repeated injections may cause atrophy of the muscle over time. Additionally, treatment may be undertaken sooner at about 3 months after onset with the possibility of earlier re-establishment of binocularity and decreased amblyopia risk. It has a relatively painless post-operative period and it is a less invasive procedure with a theoretical reduction in risk of endophthalmitis due to the lack of scleral passes. The disadvantages include an overall lower success rate, thus necessitating the identification of strabismus subtypes that have the highest potential for success. There is a lower rate of success in those patients that lack binocular potential and that have large angle infantile esotropia. Patients may also have a longer duration of post-operative over-correction and higher incidence of transient ptosis and vertical deviations. The authors identify subsets of patients that they feel would have the most likely benefit from the use of BT. Acute onset comitant esotropia was studied and found that 81% of patients who received BT achieved alignment of 10 PD or less with no statistical significance in the success rate compared to surgery, and those patients were treated 3 months earlier. Patients with esotropia and greater risk of overcorrection such as partially accommodative esotropia and children with CP may also be considered as an alternative to surgery.

Results of combined resection-recession on a single rectus muscle for incomitant deviations-an alternative to the posterior fixation suture.
In this retrospective case series the outcomes of combined resection and recession on previously unoperated single horizontal or vertical rectus muscles were analyzed. The patients included were consecutive adult patients with acquired incomitant deviations, minimal in primary gaze and maximal in an eccentric gaze position. The surgical technique used included recessions for the maximal deviations combined with smaller resections using hang-back, nonadjustable sutures. The primary outcome of the study was a decrease the incomitance by 50%. Other outcomes were expansion of the field of binocular single vision, and relieve diplopia. Pre- and postoperative incomitance was compared using the paired t test. A total of 16 adults were studied (mean age at surgery, 49.3 +/- 17.5 years), 12 with incomitant vertical deviations and 4 with incomitant horizontal deviations. Eight patients had preoperative deviations of <2Delta in primary gaze (mean, 9.2Delta +/- 10.5Delta; range, 1Delta-35Delta). The mean maximum eccentric gaze deviation was 21.4Delta +/- 9.9Delta (range, 10Delta-48Delta). Postoperatively, 12 patients (75%) had a decrease in incomitance of >50%, and all had expansion of the field of binocular single vision. Improvement in postoperative incomitance was highly statistically significant in the vertical incomitant group (P < 0.0001) but not statistically significant in the horizontal group (P = 0.39). The technique corrected downgaze deviations in 4 patients with canine tooth syndrome (93% +/- 3.3, P < 0.0001) without worsening the hypotropia in upgaze. The authors conclude that combined resection-recession single muscle surgery significantly reduces incomitance with minimal effect on primary gaze. It is most effective for treating vertical deviations worse on downgaze with primary gaze deviations of <2Delta and for canine tooth syndrome; the technique was less successful in reducing horizontal incomitance and in cases involving gaze palsies and nystagmus. Despite the limitations of a retrospective study, this important work demonstrates the advantages of using combined resection-recession single muscle surgery in difficult incomitant cases mainly in vertical cases. It is possible that the results were not as impressive in horizontal cases because only four cases were included. The paper discusses different aspects of surgical planning and reviews previous publications on this technique, which the reader may find very useful.

11. ANTERIOR SEGMENT

Corneal collagen cross-linking in paediatric patients affected by keratoconus

Corneal collagen cross-linking (CXL) is becoming a standard treatment for people with progressive keratoconus (KCN). Its safety and efficacy has been
demonstrated in the pediatric population. In this study, the authors conducted a prospective cohort study of children treated with CXL for advanced keratoconus. The study included 43 consecutive patients (52 eyes, with average age 14.63 years) with progressive KCN (defined as 1.5D increase in topography within 1 year or loss of BCVA by one line or more). Traditional corneal CXL was performed with 0.1% riboflavin soaking for 30 minutes and 30 minutes irradiation. After treatment, a significant decrease in maximum keratometry from 59.30 to 57.07 was found two years after treatment. BCVA improved from 0.17 to 0.15 LogMAR (but not statistically significant). The eyes with worse keratometry improved from 64.94D to 62.25D (p<0.001). Endothelial cell density was stable. One patient had progression after treatment, but was stabilized after re-treatment. Another patient underwent later deep anterior lamellar keratoplasty. All cases had mild corneal haze after treatment that resolved 6 to 12 months later. Based on these results the authors conclude the procedure is safe and effective in stabilizing KCN, particularly in advanced KCN with high initial keratometry readings.

A New Viscous Cysteamine Eye Drops Treatment for Ophthalmic Cystinosis: An Open-Label Randomized Comparative Phase III Pivotal Study

The purpose of this study was to evaluate the efficacy of new viscous cysteamine hydrochloride (CH) eye drops (vCH 0.55%) compared to standard CH 0.10% drops in the treatment of ophthalmic cystinosis. This was an open-label, phase III, randomized, two-arm multicenter trial conducted at 2 centers in France. Cystinosis patients ≥2 years old were randomized to receive either vCH 0.55% (15 patients) or CH 0.10% (16 patients) drops, 4 times per day for 90 days in both eyes. The authors compared the superiority in reducing corneal cystine crystal density as assessed by in vivo confocal microscopy (IVCM), evaluated photophobia, corneal cystine crystal scores (CCCSs), and cystine crystal depth measured by optical coherence tomography. Safety objectives were to assess adverse events (AEs), local adverse drug reactions, and ocular safety parameters. The mean absolute change in IVCM total score at day 90 in the vCH 0.55% drops group (-4.6 ± 3.1) was significantly greater than and superior to the mean absolute change in the CH 0.10% drops group (-0.46 ± 3.38; P < 0.0001). Photophobia, CCCS, and corneal cystine crystal depth were significantly more improved in the vCH 0.55% drops group than in the CH 0.10% group. The most frequent local adverse drug reactions in both groups were stinging, burning, redness, and blurred vision, none of which resulted in discontinuation of treatment. vCH 0.55% was superior to treatment with CH 0.10% drops, and offer improved convenience and ease of storage. CH 0.10% drops typically require 6-12 times per day usage and refrigeration and storage in a dark environment to remain stable, whereas vCH 0.55% is stable for up to 7 days after opening at room temper-
nature. This study is important in that the replacement of CH 0.10% with vCH 0.55% could be life-changing for children suffering from cystinosis.

Steroid-Sparing Effect of 0.1% Tacrolimus Eye Drop for Treatment of Shield Ulcer and Corneal Epitheliopathy in Refractory Allergic Ocular Diseases

Topical calcineurin inhibitors were recently introduced to treat severe allergic conjunctival diseases with remarkable success. The purpose of this study was to determine whether topical tacrolimus alone or with adjuvant steroids can cure corneal epitheliopathy and shield ulcers in patients with refractory allergic ocular diseases. The authors retrospectively analyzed 791 cases followed at 330 ophthalmological institutions in Japan between 2008 and 2016. Inclusion criteria were presence of corneal epitheliopathy or shield ulcers, persistent or relapsing allergic conjunctivitis, and age < 40 years. The effectiveness of the treatment was determined by a corneal epitheliopathy score during the 3-month follow-up period. The clinical signs were rated on a 4-grade scale. Corneal epitheliopathy with no corneal staining was graded as 0, and shield ulcers or plaques were graded as 3, the highest grade. The effects of tacrolimus with and without topical steroids on the epitheliopathy scores were assessed after adjustments for the severity of the clinical signs and characteristics. Results show that adjusted mean epitheliopathy score at the baseline was 1.73 (95% CI, 1.65-1.81) for patients treated with tacrolimus alone, and this was significantly reduced by -0.93 at 1 month. The reduction of the score by topical and oral steroids was -0.02 for fluorometholone, 0.02 for betamethasone, and -0.02 for oral steroids, and these reductions were not significant compared with the reduction effect of topical tacrolimus alone at -0.93. The 238 patients with shield ulcer (score 3) were analyzed with adjustments, and the mean epitheliopathy score at 1 month was reduced to 1.38 with tacrolimus alone (95% CI, 1.24-1.51), 1.41 (95% CI, 1.26-1.56) with adjuvant fluorometholone, and 1.46 (95% CI, 1.32-1.61) with adjuvant betamethasone. No significant difference was observed in the adjunctive topical steroids. The presence of severe palpebral conjunctival symptoms, including giant papillae, was a significant resisting factor for topical tacrolimus. This is an effective steroid-sparing agent to be used to treat allergic ocular disease that can be common in children. Tacrolimus is available only as dermatologic preparation in the US

12. **CATARACT**
Pediatric cataract surgery outcomes

Benchmarks for outcome indicators in pediatric cataract surgery.

Nihalani BR, VanderVeen DK. Eye (2017) 31, 417–421

Quality assurance programs have been instituted to identify the potential for improving outcomes. The most commonly used indicators in adult cataract surgery are best corrected visual acuity (BCVA) and refractive accuracy as reported in multiple benchmark studies. There are no publications focused on benchmark indicators in pediatric cataract surgery. The aim of our study was to establish valid benchmark indicators in the pediatric population. Retrospective chart review of all patients older than 2 years of age undergoing cataract surgery with primary IOL implantation over an 11-year period (November 2005–February 2016). Exclusion criteria included ocular comorbidities known to potentially result in poor vision or inability to obtain accurate biometry (corneal opacity, glaucoma, uveitis, trauma, manifest nystagmus, retinal disease, or subluxated lenses). Data collected included pre- and post-operative VA measures, biometry data, and refractive outcomes. A total of eight different surgeons performed the procedures in this study. All children from 2 to 5 years of age received posterior capsulotomy and anterior vitrectomy, and children older than 5 years did not receive posterior capsulotomy or anterior vitrectomy. Two separate outcome measures were studied. Best corrected visual acuity. Only patients aged 2 years or older at the time of surgery, who were treated with bilateral cataract surgery, who were followed for at least 3 months after surgery, and who had a final VA measured with Snellen letters were included. This eliminated the possibility of dense amblyopia from congenital cataract with late presentation, or those with dense amblyopia due to unilaterality.

Prediction error absolute PE were calculated in the following manner: PE = predicted refraction – actual refraction
Absolute PE = |predicted refraction – actual refraction| Predicted refraction was calculated for the IOL power that was implanted in the eye using AL, K, and the manufacturer’s A-constant. One hundred and twenty-four eyes of 62 patients with bilateral cataract surgery were analyzed for VA outcomes. Mean age at surgery in this group was 8.3 ± 4.6 years (median age: 6.8 years). Mean follow-up duration was 3.7 ± 2.7 years. All but one patient had IOL implantation within the capsular bag. The IOL power was reduced by 1.0 D in the patient with sulcus implantation. BCVA at the last visit was
20/40 or better in 96% eyes. PE calculations were performed for 235 eyes of 179 patients (56 bilateral, 123 unilateral). The mean age at surgery was 6.3 ± 4.8 years. The mean AL was 22.3 ± 1.8 mm. The mean PE was 0.3 ± 1.1 D and the mean absolute PE was 0.9 ± 0.7 D. The PE was within 0.5 D in 43% eyes, 1.0 D of target in 66% eyes, and 2.0 D of target in 95% eyes. The mean absolute PE in the group of eyes with shorter AL was higher compared to eyes with long AL and the difference was significant statistically.

Quality management based on outcome indicators is increasingly finding its way into Ophthalmology practices. A reference for good quality or best practice is needed, the so-called benchmark. In the present study, children with bilateral cataract surgery achieved excellent VA outcomes, which is comparable to outcomes reported for surgery in adult eyes. For quality outcome measures, authors suggest that children older than 2 years at the time of bilateral cataract surgery with primary IOL implantation should achieve excellent visual outcomes in 96% of eyes. The PE in pediatric eyes is somewhat greater than benchmark reported in adult population studies, so that overall only 66% are within 1 D of the target refraction. Pediatric patients often represent ‘complicated’ cases as the surgery can be technically challenging compared with the adult cataract surgery. VA measures can be compromised cooperation and co-existing conditions such as amblyopia, latent nystagmus, strabismus, or intentionally planned residual refractive error.

Myopic Shift 5 Years after Intraocular Lens Implantation in the Infant Aphakia Treatment Study.

The Infant Aphakia treatment study is (IATS) is a randomized clinical trial comparing the visual outcome in infants 1 to 6 months of age who underwent primary implantation of an IOL vs. being left aphakic and receiving a contact lens correction after cataract surgery in infancy. These infants were targeted for 8 D undercorrection for infants aged < 48 days and a 6 D undercorrection for infants aged 48 to 210 days. Refractive error was measured at 1 month and 3 months and then at 3-month intervals until age 4.5 years and then at 5 years. The change in refraction over time was estimated by linear mixed model analysis. Intraocular lens implantation was completed in 56 eyes; 43 were analyzed (median age, 2.4 months; range, 1.0-6.8 months). Exclusions included 11 patients with glaucoma, 1 patient with Stickler syndrome, and 1 patient with an IOL exchange at 8 months postoperatively due 8 D of myopic shift between the visits 3 and 6months. The mean rate of change in a myopic direction from 1 month after cataract surgery to age 1.5 years was 0.35 diopters (D)/month (95% CI, 0.29-0.40 D/month); after age 1.5 years, the mean rate of change in a myopic direction was 0.97 D/year (95% CI, 0.66-1.28 D/year). The mean refractive change was 8.97 D (95% CI, 7.25-10.68 D) at age 5 years for children 1 month of age at surgery and
7.22 D (95% CI, 5.54-8.91 D) for children 6 months of age at surgery. The mean refractive error at age 5 years was -2.53 D (95% CI, -4.05 to -1.02). After IOL implantation during infancy, the rate of myopic shift occurs most rapidly during the first 1.5 years of life. Myopic shift varies substantially among patients. If the goal is emmetropia at age 5 years, then the immediate postoperative hypermetropic targets should be +10.5 D at 4 to 6 weeks and +8.50 D from 7 weeks to 6 months. However, even using these targets, it is likely that many children will require additional refractive correction given the high variability of refractive outcomes.

**Pediatric cataract surgery complications**

Endophthalmitis following Pediatric Cataract Surgery: An International Pediatric Ophthalmology and Strabismus Council Global Perspective.

Almutez M. Gharaibeh, Luis H. Ospina, Eedy Mezer, Tamara Wygnaski-Jaffe


The purpose of this study is to compile international data on the risk factors, diagnosis, and treatment of endophthalmitis following pediatric cataract surgery. An e-mail containing a link to an online survey was sent to all members of the American Association for Pediatric Ophthalmology and Strabismus. The questionnaire examined the incidence, risk factors, treatment, outcomes, and prophylaxis of endophthalmitis following pediatric cataract surgery around the world. Two hundred thirty-seven ophthalmologists answered the questionnaire. Eight ophthalmologists (3.4%) encountered 22 cases of endophthalmitis following pediatric cataract surgery during their practice. Most patients with endophthalmitis following pediatric cataract surgery were 2 to 4 years of age (36.4%). An intraocular lens was implanted in 59.1% of cases, most of which were acrylic intraocular lenses (53.8%). The main presenting symptoms were photophobia (50%) and pain (40.9%). The most common signs were conjunctival injection (36.4%) and hypopyon (31.8%). The final visual acuity was counting fingers or worse in 86% of cases. The most common cultured organism was *Staphylococcus aureus* (31.8%). The most common management of endophthalmitis following pediatric cataract surgery was a combination of intravitreal, systemic, and topical antibiotics (36.4%). Most ophthalmologists (68.2%) administered prophylactic intracameral antibiotic treatment during surgery and 50% used vancomycin. The authors conclude that endophthalmitis following pediatric cataract surgery is an uncommon, multifactorial complication with poor visual prognosis. Efforts directed at minimizing its risk, such as treating potential predisposing systemic conditions, improving sterilization techniques, optimizing operative conditions to reduce complications and surgery duration, and using subconjunctival and intracameral antibiotics, decrease its incidence. Early postoperative evaluation, subsequent follow-up visits, and keeping a high index of suspicion should facilitate the recog-
nition of endophthalmitis following pediatric cataract surgery to avoid delaying treatment.

14. GLAUCOMA

15. REFRACTIVE SURGERY

Pediatric Refractive Surgery
Erin D. Stahl Curr Opin Ophthalmol July 2017;28:305-309

The author embarks on a review of pediatric refractive surgery. Poor patient cooperation requiring sedation post-op eye rubbing and the use of relatively immobile equipment make hospital based procedures not readily available. Long term corneal changes due to increased inflammatory response in children leading to haze and the continued growth of the eye leading to possible corneal thinning and refractive error shift are mentioned. Many patients to be considered for laser procedures have high refractive errors that exceed the abilities of the equipment. Patients younger than 18 must undergo special informed consent for both laser and phakic IOL (pIOL) placement with notification of off-label use. The indications for the procedure are most commonly anisometropic amblyopia, high ametropia, and refractive accommodative ET and in children with neurobehavioral issues that may not tolerate traditional therapy. LASEK and PRK have no flap and increased corneal stability but greater discomfort and healing time and LASIK has the converse. Lensectomy, pIOL, and refractive lens exchange have improved optics over spectacles, and correct very high refractive errors but the disadvantages of intraocular surgery and possible endothelial cell loss (ECL), UGH syndrome and cataract formation. The author reviews the published literature and highlights that in the studies done on laser procedures most had improved vision, stereo, and refractive correction. In those for ET, patients were ortho with low residual refractive errors. There are 7 published studies on pIOLs and endothelial cell loss was the most common complication as well as pupillary block and pigment dispersion. No lenses had to be removed. For the future, a large study for long term safety and efficacy of refractive surgery vs traditional amblyopia therapy when used shortly after diagnosis is needed. Also, long term effects of pIOLs on ECL, cataract formation, IOP and change in lens position over time.

In summary, the author reviews refractive surgery considerations, indications for the procedure and the current literature which are all case series to highlight the need for a conscientious look at long and short term benefits of these procedures balanced with treating amblyopia for best results and avoiding potentially vision threatening complications for the patients.
Leber’s hereditary optic neuropathy (LHON) was first associated with a G-to-A transition at nt-11778 in the ND4 subunit gene of complex I of mitochondrial DNA. The authors recoded the ND4 subunit of complex I in the universal genetic code and imported it into mitochondrion from the cytoplasm by adding a targeting sequence (from P1 isoform of subunit c of ATP synthase). This combined sequence is referred as P1ND4v2. This was inserted into a self-complementary adeno-associated vector scAAV2(Y444, 500, 730F). This is a report on safety of their long-term follow-up of LHON patients who were treated with low and medium doses of this vector, AAV2(Y444,500,730F)-P1ND4v2. Fourteen patients with visual loss and mutated G11778A mitochondrial DNA were enrolled and received the injection of the vector to one eye. Six participants with chronic bilateral visual loss lasting more than 12 months (group 1), 6 participants with bilateral visual loss lasting less than 12 months (group 2), and 2 participants with unilateral visual loss (group 3) were treated. Nine patients had at least 12 months of follow-up. Clinical testing included visual acuity, visual fields, optical coherence tomography, pattern electroretinography, and neuro-ophthalmic examinations. Generalized estimating equation methods were used for longitudinal analyses. The main outcome was visual acuity. For groups 1 and 2, month 12 average acuity improvements with treatment relative to baseline were 0.24 logMAR. Fellow eyes had a 0.09 logMAR improvement. A post hoc comparison found that at month 12, the difference between study eye minus fellow eye improvement in group 2 patients of 0.53 logMAR was greater than that observed in our prior acute natural history patients of 0.21 logMAR (P = 0.053). At month 18, the difference between study eye minus fellow eye improvement in the acute group 2 gene therapy patients of 0.96 was more than that observed in the prior acute natural history patients (0.17 logMAR; P < 0.001). Two patients demonstrated asymptomatic uveitis that resolved without treatment. Optical coherence tomography of treated eyes showed an average temporal retinal nerve fiber layer thickness of 54 μm before injection and 55 μm at month 12. For fellow eyes before injection, it was 56 μm, decreasing to 50 μm at month 12 (P = 0.013). Generalized estimating equations suggested that PERG amplitudes worsened more in treated eyes than in fellow eyes by approximately 0.05 μV (P = 0.009 exchangeable). No difference between eyes in outcomes of other visual function measures was evident. The authors concluded that 12 month follow-up of this allotropic gene therapy for LHON seems safe and does not damage the temporal retinal nerve fiber layer, opening the door next for testing of the high dose.

Infantile nystagmus syndrome (INS) is a group of disorders presenting with genetic and clinical heterogeneities that have challenged the genetic and clinical diagnoses of INS. Precise molecular diagnosis in early infancy may result in more accurate genetic counseling and improved patient management. This study aims to assess the accuracy of genomic data from next-generation sequencing (NGS) and phenotypic data to enhance the definitive diagnosis of INS.

A single-center retrospective case series was conducted in 48 unrelated, consecutive patients with INS, with or without associated ocular or systemic conditions, who underwent genetic testing between June 1, 2015, and January 31, 2017. Next-generation sequencing analysis was performed using a target panel that included 113 genes associated with INS (n = 47) or a TruSight One sequencing panel that included 4813 genes associated with known human phenotypes (n = 1). Variants were filtered and prioritized by in-depth clinical review, and finally classified according to the American College of Medical Genetics and Genomics guidelines. Patients underwent a detailed ophthalmic examination, including electroretinography and optical coherence tomography, if feasible.

Among the 48 patients (21 female and 27 male; mean [SD] age at genetic testing, 9.2 [10.3] years), 8 had a family history of nystagmus and 40 were simplex. All patients were of a single ethnicity (Korean). Genetic variants that were highly likely to be causative were identified in 28 of the 48 patients, corresponding to a molecular diagnostic yield of 58.3% (95% CI, 44.4%-72.2%). FRMD7, GPR143, and PAX6 mutations appeared to be the major genetic causes of familial INS. A total of 10 patients (21%) were reclassified to a different diagnosis based on results of NGS testing, enabling accurate clinical management.

These findings suggest that NGS is an accurate diagnostic tool to differentiate causes of INS because diagnostic tests, such as electroretinography and optical coherence tomography, are not easily applicable in young infants. Accurate application of NGS using a standardized, stepwise, team-based approach in early childhood not only facilitated early molecular diagnosis but also led to improved personalized management in patients with INS.

Early Patterns of Macular Degeneration in ABCA4-Associated Retinopathy.


The authors describe the earliest features of ABCA4-associated retinopathy. This is a case series of children with a clinical and molecular diagnosis of ABCA4-associated retinopathy without evidence of macular atrophy. The retinal phenotype was characterized by color fundus photography, OCT, fundus autofluores-
cence (FAF) imaging, electroretinography, and in 2 patients, adaptive optics scanning laser ophthalmoscopy (AOSLO). Sequencing of the ABCA4 gene was performed in all patients.

Eight children with ABCA4-associated retinopathy without macular atrophy were identified. Biallelic variants in ABCA4 were identified in all patients. Four children were asymptomatic, and 4 reported loss of VA. Patients were young (median age, 8.5 years; interquartile range, 6.8 years) with good visual acuity (median, 0.155 logarithm of the minimum angle of resolution [logMAR]; interquartile range, 0.29 logMAR). At presentation, the macula appeared normal (n = 3), had a subtly altered foveal reflex (n = 4), or demonstrated manifest fine yellow dots (n = 1). Fundus autofluorescence identified hyperautofluorescent dots in the central macula in 3 patients, 2 of whom showed a normal fundus appearance. Only 1 child had widespread hyperautofluorescent retinal flecks at presentation. OCT imaging identified hyperreflectivity at the base of the outer nuclear layer in all 8 patients. Where loss of outer nuclear volume was evident, this appeared to occur preferentially at a perifoveal locus. Longitudinal split-detector AOSLO imaging in 2 individuals confirmed that the greatest change in cone spacing occurred in the perifoveal, and not foveolar, photoreceptors. Electroretinography showed a reduced B-wave-to-A-wave ratio in 3 of 5 patients tested; in 2 children, recordings clearly showed electronegative results.

Authors conclude that in childhood-onset ABCA4-associated retinopathy, the earliest stages of macular atrophy involve the parafovea and spare the foveola. In some cases, these changes are predated by tiny, foveal, yellow, hyperautofluorescent dots. Hyperreflectivity at the base of the outer nuclear layer, previously described as thickening of the external limiting membrane, is likely to represent a structural change at the level of the foveal cone nuclei. Electroretinography suggests that the initial site of retinal dysfunction may occur after phototransduction.

17. TRAUMA

NON-ACCIDENTAL HEAD TRAUMA

Characteristics of non-vitreoretinal ocular injury in child maltreatment: a systematic review

The National Society for the Prevention of Cruelty to Children survey data reported that 6.9% young people aged 11–17 had experienced abuse or neglect at the hands of their parents or guardians. This systematic review was undertaken to identify the spectrum of non-retinal ocular abusive injury. Studies of children aged 0–18 years experiencing non-vitreoretinal ocular injury due to physical abuse or fabricated or induced illness, with adequate confirmation of the cause of injury and details of the injuries sustained. Any study that included cases of

TRAUMA
‘suspected’ abuse or that relied solely on physical findings without a multidisciplinary assessment or publications where the children had not been examined by an ophthalmologist, or a healthcare worker that performed regular ocular examinations were excluded. Five of 49 articles reviewed met the inclusion criteria. Total data includes 26 children, 14 males, and 12 females. Mean age across the included articles was 36.0 months, range 1.0–168.0 months. Authors reported 3 data sets: data set 1 ocular injury as a consequence of physical abuse; data set 2: ocular injury as a result of fabricated or induced illness (FII) and data set 3: ocular injury as a result of corporal punishment. Data set 1 included 18 patients. The most common finding (100%) was subconjunctival hemorrhage. Four of those patients (22%) were seen before with ocular complaints and discharge without maltreatment being recognized. Data set 2 included one 5-month girl who underwent repeated examination, and on the fifth presentation a diagnosis of maltreatment was made following the identification of uncharacteristic ocular findings. Data set 3 included 7 patients with an age range of 4 to 14 years who sustained trauma with a belt. These children are significantly older than those in Data sets 1 and 2. All had hyphema frequently associated ocular and extra-ocular clinical findings and significantly impaired vision.

It is estimated that in 33% of patients the diagnosis of physical abuse is initially missed. All the children that had suffered physical abuse with ocular injury had subconjunctival hemorrhages. Unexplained subconjunctival hemorrhages may be a potential sentinel injury of maltreatment and warrant careful evaluation. This study confirms the wide spectrum of non-vitreoretinal ocular injuries seen in child abuse or fabricated or induced illness.

18. RETINA

Comparison of Visual Outcomes in Coats’ Disease: A 20-Year Experience.

This is a single-center retrospective cohort study of patients with Coats’ disease. All consecutive patients aged 18 years or younger at presentation have Coats disease identified clinically, angiographically, or both from 1995 through 2015. Patients were divided into 2 groups based on date of presentation: decade 1 (1995-2005) and decade 2 (2006-2015). Management methods included observation (defined as no treatment for posterior manifestations of Coats’ disease; some patients in this group still underwent cataract or strabismus surgery); ablative therapies including cryotherapy, 532-nm laser, or both; vitreoretinal surgery, which included any combination of subretinal fluid drainage, scleral buckle, pars plana vitrectomy, epiretinal membrane removal, and intraocular gas or silicone oil tamponade; IVT injection; or enucleation. After 2008, off-label intravitreal bevacizumab was given to selected eyes based on treating physician preference. Of
the total 55 patients identified 39 patient met the inclusion criteria. Eyes were classed into the following stages: Stage 1 has retinal telangiectasia (RT) only; stage 2A refers to eyes with RT and extrafoveal exudation; stage 2B denotes eyes with RT and foveal exudation; stage 3A represents eyes with RT, exudation, and subtotal retinal detachment (RD); stage 3B describes eyes with RT, exudation, and total RD; stage 4 eyes demonstrate RT, exudation, total RD, and secondary glaucoma; and stage 5 eyes are defined as blind eyes with RT, exudation, total RD, and anterior chamber involvement or phthisis (advanced end-stage disease). Forty-seven percent of eyes in decade 1 demonstrated advanced stages of disease (stage 3B or worse) compared with 20% of eyes in decade 2. There was a trend for the mean initial presenting VA (±SD) for decade 1 eyes to be worse (2.05±1.29 logMAR) than for decade 2 eyes (1.45±0.99 logMAR; P = 0.1). From initial to final follow-up visit, mean VA also worsened for decade 1 eyes (P = 0.03), but remained stable for decade 2 eyes (P = 1.0). At the end of follow-up, there was a trend for mean VA for decade 1 eyes (2.28±1.17 logMAR) to be worse than for decade 2 eyes (1.60±1.15 logMAR; P = 0.07). The authors concluded that the earlier presentation of disease in decade 2 suggests improvements in disease detection over time. Furthermore, there was a trend for eyes to have better final VA in this decade. This is due to a combination of factors, including earlier presentation of disease, fewer eyes being observed without treatment, and eyes, when treated, receiving a higher number of procedures.

Vancomycin-Associated Hemorrhagic Occlusive Retinal Vasculitis: Clinical Characteristics of 36 Eyes.

This is a non-pediatric disorder but nonetheless an important disease entity to be aware of for all ophthalmologists and those performing pediatric cataract surgery. Hemorrhagic occlusive retinal vasculitis is a rare but potentially devastating condition that can develop after cataract surgery or intraocular injection. The authors report 36 eyes of 23 patients that developed HORV after receiving intraocular vancomycin via intracameral bolus (33/36) and via intravitreal injection (1/36) or through the irrigation bottle (2/36). Characteristic findings of HORV included unremarkable postoperative day 1 undilated examination, delayed-onset painless vision loss, mild anterior chamber and vitreous inflammation, sectoral retinal hemorrhages in areas of ischemia, and predilection for venules and peripheral involvement. Patients sought treatment with HORV 1 to 21 days after surgery or intravitreal injection. Visual results usually were poor: 22 of 36 eyes (61%) had 20/200 or worse visual acuity and 8 of 36 eyes (22%) had no light perception (NLP). Neovascular glaucoma developed in 20 of 36 eyes (56%). Seven eyes received additional intravitreal vancomycin after surgery; 5 of these 7 eyes had NLP visual acuity at the most recent examination. Three eyes received intravitreal corticosteroids and had final visual acuities of 20/40, 20/70,
and hand movements. Disease course and findings suggest that HORV is caused by a delayed hypersensitivity reaction to vancomycin. Early treatment with corticosteroids likely is beneficial. Subsequently, anti-vascular endothelial growth factor injections and panretinal photocoagulation are important to prevent neovascular glaucoma, a common complication. Avoidance of additional intravitreal vancomycin is recommended if HORV is suspected.

**Association of Maternal Smoking During Pregnancy and Birth Weight with Retinal Nerve Fiber Layer Thickness in Children Aged 11 or 12 Years: The Copenhagen Child Cohort 2000 Eye Study**


This is a prospective, population-based cohort eye study of 1406 children born in 2000 in Copenhagen, Denmark. From this cohort, an eye exam, including evaluation of peripapillary retinal nerve fiber layer (RNFL) thickness was performed on 1323 children at 11 or 12 years old. Exposure to maternal smoking and low birth weight were independently associated with having a thinner RNFL at age 11 or 12 years. As previous research also suggests, this large cohort study found it is better to avoid smoking during pregnancy to avoid retina and optic nerve abnormalities in children to prevent amblyopia.

**Use of a Carbonic Anhydrase Inhibitor in X-Linked Retinoschisis: Effect on Cystic-Appearing Macular Lesions and Visual Acuity**


This retrospective analysis sought to evaluate changes in cystic-appearing macular lesions and visual acuity in patients with X-linked retinoschisis being treated with a carbonic anhydrase inhibitor. 68 eyes from 36 patients between the ages 5 – 61 years were monitored. The most commonly used CAI was dorzolamide in 86%. Macular cystic-appearing lesions were monitored with OCT, and analyses for changes in visual acuity and macular cysts included comparisons between treatment and pretreatment segments. 45 eyes (66%) had a reduction of their cysts while on a carbonic anhydrase inhibitor. 20 eyes (29%) showed no discernable change in cystic appearance on OCT while on a CAI, and 3 eyes (4%) demonstrated worsening of their cysts with treatment. The estimated average ETDRS equivalent improvement in acuity was 0.09 logMAR, or slightly less than one line on the ETDRS chart. Although the acuity improvement is small and of uncertain clinical significance, the authors argue that better preservation of retinal structure by reducing retinal thickness associated with reduction in the size of cystic lesions could result in long-term preservation of visual acuity by limiting the development of atrophic macular lesions.
**Vigabatrin Toxicity in Infancy is Associated with Retinal Defect in Adolescence: A Prospective Observational Study**


This prospective cross-sectional study evaluated whether vigabatrin (VGB)-attributed retinal toxicity defined by ERG in early childhood is associated with visual system defect in adolescents after discontinuation of VGB. 24 children aged 7 years or older who were previously treated with VGB and monitored in early childhood by ERG were included; 10 had been diagnosed with VGB-attributed retinal defect (Group I) and 14 had no VGB-attributed retinal defect (Group II). The investigators assessed the extent of monocular visual fields using Goldmann kinetic perimetry, and RNFL thickness at the optic nerve head using OCT. Of those children able to complete testing (6 eyes in Group I and 16 eyes in Group II), Goldmann results revealed visual field loss in Group I and not in Group II. OCT demonstrated attenuation of the RNFL in all 6 eyes of Group I subjects and in 1/10 eyes of Group II subjects. The reduction in nerve fiber layer was associated with the severity of the functional reduction in amplitude of the 30-Hz flicker from baseline, and the most prominent difference between individuals in Groups I and II occurred at the inferior and superior quadrants of the optic nerve head with relative sparing of the temporal quadrant. It is not known whether seizure type, developmental delay, or the presence of other comorbidities have an effect on the risk of developing visual field defects, which is a possible confounder in this cohort. Some of the tested subjects also took other antiseizure medications that may have contributed to the observed visual field defects. In addition, the 30-Hz flicker can be abnormal unrelated to VGB, though this short-fall was mitigated by defining toxicity based on each child’s own baseline ERG response. Another study limitation is the lack of control for the number of ERG assessments: individuals with more assessments are more likely to be categorized as having toxicity. Group I participants were treated with VGB for a longer period of time than Group II participants. Despite these limitations, this study associates visual field reductions and RNFL attenuation with previously determined VGB toxicity as measured by ERG. Incorporating ERG and OCT could be advantageous in monitoring VGB use in a patient population that is unable to undergo standard visual field testing.

**OCT IMAGING – DATA ON NORMAL EYES**

Retinal structure assessed by OCT as a biomarker of brain development in children born small for gestational age
Previous research has shown thinning in the retinal nerve fiber layer (RNFL) in school-age children born small for gestational age (SGA). Also, thinner RNFL may relate to brain structure and neurodevelopment in early preterm infants. This study evaluated the relationship between retinal structure and brain changes in children age 6-16 who were born SGA. The children in the cohort underwent full ophthalmological exam and retinal imaging with SD-OCT. 25 children born SGA were paired with 25 children born at appropriate weight for gestational age. On MRI, SGA children showed lower total white matter, parietal lobe, and thalamus volumes. No direct correlation was found between retinal thickness and brain volumes. Children with abnormal OCT (GCL-IPL thickness) did show lower total intracranial volumes, decreased total gray and white matter volumes, and other decreased volumes in certain brain regions. Therefore, retinal ganglion cell layer is a potential biomarker of neuronal damage in the brain of children born SGA. The GCL-IPL seems to be the most affected structure, with its thinning corresponding to the most profound brain anomalies.

**MISCELLANEOUS**

**Progressive Retinal Vasodilation in Patients With Type 1 Diabetes: A Longitudinal Study of Retinal Vascular Geometry**


This study evaluated longitudinal retinal vascular geometry (RVG) changes in adolescents with type 1 diabetes to determine whether chronic diabetes complications could be predicted. The authors followed 102 adolescents (baseline: 47.1% male, mean [SD] age 14.4 [1.6] years, diabetes duration 7.2 [3.1] years, HbA1c 8.1% [1.3%] over three visits, with a mean follow-up of 2.6 years. Retinal vascular geometry was measured using a standardized computer-assisted protocol from retinal photographs at each visit. Multivariable linear mixed-models and logistic regression were used to examine predictors of RVG and diabetic retinopathy. During follow-up, mean arteriolar caliber, venular caliber, and venular tortuosity increased, from 156.0 (SD, 14.5) to 164.9 (14.0) µm, 215.9 (22.5) to 230.3 (20.6) µm, and 1.096 (0.014) to 1.099 (0.016), respectively (all P < 0.005). Other RVG measurements (fractal dimension, branching angle, length to diameter ratio) remained stable. Higher than baseline HbA1c and longer diabetes duration were associated with greater venular vasodilation. Retinopathy developed at any time-point in 24% of subjects, and the highest tertile arteriolar fractal dimension was associated with cumulative incidence of retinopathy (multivariable odds ratio 3.2, 95% confidence interval 1.0–9.6; P = 0.04), suggesting value as a potential biomarker for diabetic complications. Limitations of this study include small sample size (limiting number of variables able to be tested), and less-motivated participants (who did not show up for 3 visits) may have had poorer systemic
metabolic control and may not have been included in the study, so results may not be generalizable to this group.

## 19. RETINOBLASTOMA / INTRAOCULAR TUMORS

### RETINOBLASTOMA

Reduction of severe visual loss and complications following intra-arterial chemotherapy (IAC) for refractory retinoblastoma


There is limited safety profile data for intra-arterial chemotherapy (IAC) in the management of retinoblastoma. Risk factors for visual loss include high doses of melphalan, catheterization complications, and previous radiotherapy. In this paper the authors conducted a retrospective cohort study to evaluate how modification of these factors could lessen complications. They identified 9 eyes (9 patients) treated with IAC from January 2013 to December 2015 that met inclusion criteria (tumors involving the fovea were excluded). Median age at first treatment was 14 months. There was difficulty in 7 of 27 catheterizations. Six patients suffered severe autonomic episodes. One patient developed a temporary sixth nerve palsy and choroidal ischemia, but the ischemia was nasal and did not affect visual acuity. Tumor control was achieved in 6 eyes, and 3 went on to eventually have enucleation. No child had deterioration of vision (prior to the enucleation in the 3 cases for progressive disease). There were two cases of slight ptosis and one patient had a sluggish pupil at last follow-up. 8/9 patients had normal post-treatment ERG’s, with one showing subtle reduction of cone and rod function. The authors conclude that visual and ocular motility complications may be reduced by giving age-adjusted doses of melphalan.

### Efficacy and Toxicity of Intravitreous Chemotherapy for Retinoblastoma: Four-Year Experience.


Intravitreous chemotherapy (IVC) for retinoblastoma has shown that it effectively treats vitreous seeds and saves eyes that once would have been enucleated. The authors previously reported a 5.8-μV decrease in ERG recording for every injection. Toxic effects can also be seen in the anterior segment of the eye including iris recession, cataract, iris depigmentation and iris thinning along with scleromalacia. Alternative to IVC is intra-arterial chemotherapy (IAC), which requires a team of experts and resources not readily available in all retinoblastoma
centers. The authors conducted a retrospective investigation of the efficacy and toxicity of intravitreous melphalan for treatment of retinoblastoma, as a single agent or with concomitant topotecan. The study also evaluated patient and treatment characteristics to see how these factors affect retinal toxicity. A total of 130 eyes of 120 patients with retinoblastoma received 630 intravitreous (melphalan, topotecan) or topotecan periocular injections. Periocular or intravitreal topotecan was used to supplement when intravitreal melphalan did not produce a desired response. Between September 2012 and September 2016, a total of 83 (64%) of these eyes were treated with concomitant ophthalmic artery chemosurgery (OAC) using melphalan, topotecan, and carboplatin. Indirect ophthalmoscopy and clinical imaging were used to evaluate clinical response. Ocular survival and disease-free survival were estimated using Kaplan-Meier methods in 130 eyes. Ocular toxicity was evaluated by clinical findings and electroretinography (ERG) on 244 evaluable injections in 63 patients using 30-Hz flicker responses. Data were analyzed for ocular survival, disease-free survival, and ERG: peak-to-peak ERG amplitudes in response to 30-Hz photopic flicker stimulation. There were no disease- or treatment-related deaths, and no patient developed externalization of tumor or metastatic disease. Two-year Kaplan-Meier estimates of ocular survival and disease-free survival were 94.2% (95% CI, 89.2-99.4) and 86.2% (95% CI, 78.7-94.5), respectively. There was a significant association between the number of injections and diminished ERG responses, such that on average each intravitreous melphalan injection was associated with a 5.3-μV decrease in ERG amplitude (P < 0.001). Concomitant intraarterial chemotherapy (P = 0.01) and greater inherent ocular pigment also were significantly associated with a reduction in ERG (P = 0.045). Patient age and weight, new injection site location, addition of topotecan, concomitant focal treatment, and time interval between injections were not significantly associated with toxicity. Intravitreous melphalan is an effective treatment for vitreous seeding in retinoblastoma, resulting in high rates of ocular survival and disease-free survival. However, in this study, each injection of melphalan was associated, on average, with a decrement in ERG response. The findings suggest increased toxicity (1) when OAC is given within 1 week of the intravitreous injection and (2) in more deeply pigmented eyes.

Optical Coherence Tomography-Guided Decisions in Retinoblastoma Management.

In this study, the authors compare clinical evaluation against OCT findings in guiding management decision in children with retinoblastoma. This was a retrospective review of all children newly diagnosed with retinoblastoma from January 2011 to December 2015 who had an OCT session during their active treatment at The Hospital for Sick Children in Toronto, Canada. The OCT sessions for fellow eyes of unilateral retinoblastoma without any suspicious lesion and those
performed more than 6 months after the last treatment were excluded. Bioptigen hand-held OCT systems were used to obtain volumetric scans composed of nonaveraged OCT scans. The data collected included age at presentation, sex, family history, RB1 mutation status, 8th edition TNMH cancer staging and International Intraocular Retinoblastoma Classification (IIRC), and number of OCT sessions per eye. An OCT session was assessed as informative if it provided sufficient data about the main indication and as directive if the information obtained guided management decisions affecting diagnosis, treatment or follow-up. Directive guidance that confirmed the pre-OCT clinical decision was considered confirmatory and influential if it changed a pre-OCT clinical decision. Details of each session were scored for indication-related details (informative or not) and assessed for guidance (directive or not), diagnosis (staging changed, new tumors found or excluded), treatment (modified, stopped, or modality shifted), or follow-up modified. Results show that sixty-three eyes of 44 children had 339 OCT sessions over the course of clinical management (median number of OCT scans per eye, 5; range, 1-15). The age at presentation and presence of a heritable RB1 mutation significantly correlated with an increased number of OCT sessions. Indications included evaluation of post-treatment scar (55%) or fovea (16%), and posterior pole scanning for new tumors (11%). Of all sessions, 92% (312/339) were informative; 19 of 27 noninformative sessions had large, elevated lesions; of these, 14 of 19 were T2a or T2b (IIRC group C or D) eyes. In 94% (293/312) of the informative sessions, OCT directed treatment decisions (58%), diagnosis (16%), and follow-up (26%). Optical coherence tomography influenced and changed management from pre-OCT clinical plans in 15% of all OCT sessions and 17% of directive sessions. The authors concluded that optical coherence tomography is an important tool in improving the accuracy of clinical evaluation in retinoblastoma management.

**NON-RETINOBLASTOMA**

Clinical Features Differentiating Benign From Malignant Conjunctival Tumors in Children

This retrospective case series (1975 to 2015) points out the importance of features that distinguish benign from malignant pediatric conjunctival tumors in 806 patients. Analysis indicated that 97% of the conjunctival lesions were benign (nevus, benign reactive lymphoid hyperplasia, nodular conjunctivitis, dermoid, primary acquired melanosis) as compared to 3% of the conjunctival lesions were malignant (melanoma, lymphoma). Features such as mean tumor thickness, tumor base measurement, location, age at presentation, lack of intrinsic cysts, and hemorrhage were the main differences between the tumors. Of these 806 patients, melanoma was associated with older children (>10 years-15 years) with a larger tumor, hemorrhage and lack of cysts as compared to nevus. Lymphoma
was associated with larger tumor size and diffuse involvement as compared to benign reactive lymphoid hyperplasia. In summary, this 40-year retrospective study of 806 children found that conjunctival tumors are nearly always benign.

20. ORBIT

The effect of enucleation on orbital growth in patients with retinoblastoma.

The purpose of this retrospective study was to measure orbital volume using serial magnetic resonance imaging (MRI) scans to determine the effect of enucleation on orbital growth over time. The medical records of patients who underwent unilateral enucleation for retinoblastoma with a minimum of 2 MRIs were reviewed. Orbital asymmetry was calculated using MRI measurements. Nonlinear and linear mixed effect regression models were used to predict the effect of age at time of enucleation on degree of orbital asymmetry. A total of 27 patients were included (mean age at enucleation, 2 years; range, 2.5 months to 5 years). Age at scan (P = 0.046) and age at enucleation (P = 0.0006) were found to have a significant effect on orbital asymmetry. Change in orbital asymmetry over time was more pronounced after enucleation in children enucleated at <1 (P < 0.0001) or <2 years of age (P = 0.0109). Younger age at enucleation was associated with a greater degree of asymmetry over time, although this effect was extinguished for patients enucleated after the age of 3 years. The authors concluded that enucleation with orbital implant before 3 years of age in patients with retinoblastoma, has a significant effect on orbital volume asymmetry. After the age of 3, this effect appears to be less detrimental to the degree of orbital asymmetry. It is well known that in children orbital growth is affected by enucleation, but this small retrospective case series clarifies the effect that age at time of enucleation has on limiting orbital growth.

Postoperative Changes in Strabismus, Ductions, Exophthalmometry, and Eyelid Retraction After Orbital Decompression for Thyroid Orbitopathy

Surgical rehabilitation of thyroid orbitopathy involves reducing proptosis, treating strabismus, lengthening the eyelids, and managing aesthetic changes. Not all are necessary in each patient; however, they often are. The current investigation intends to describe postdecompression changes that may influence the staging of these procedures. In this retrospective cohort study, records of 169 patients who
underwent orbital decompression between 1983 and 2001 were reviewed. A single orbital specialist confirmed all measurements. Time to follow up was defined as the most recent follow up after decompression and prior to any secondary procedures. No strabismus or eyelid surgery was performed at the time of decompression. Strabismus was measured with alternating prism cover test. Ductions were estimated utilizing Hirschberg’s method. Exophthalmometry was measured with Hertel. Eyelid positions were defined relative to the pupillary light reflex. Strabismus data were analyzed within eye pairs. Ductions, exophthalmometry and eyelid position were analyzed for each eye. T-test for paired data was utilized to compare means pre- and postoperatively. The study population was on average 45 years old and 73.4% women. Average length of follow up was 1.2 years. Esotropia was significantly increased after decompression by an average of 8.1 prism diopters (p < 0.01). Exotropia and vertical deviations were not significantly altered. Ductions decreased by >5 degrees in at least one meridian for 68.1% of the population. Upper eyelid retraction remained unchanged; however, lower eyelid retraction improved by 50% from 1.4 mm to 0.7 mm (p < 0.01). Exophthalmometry improved from 23.5 mm to 19.7 mm (p < 0.01), and this result was correlated with the number of walls removed (Pearson r = -0.302, p < 0.01). On average, esotropia and ductions tend to worsen with decompression surgery. This result supports the clinical dictum to avoid strabismus surgery until after decompression. The improvement in lower eyelid retraction suggests that at least lower eyelid-lengthening surgery should be reserved for after decompression, as there may be significant spontaneous improvement, while the same may not be true for upper eyelid retraction, which does not tend to change with decompression.

**Teprotumumab for Thyroid-Associated Ophthalmopathy**


Thyroid-associated ophthalmopathy, a condition commonly associated with Graves’ disease, remains difficult to treat medically. Glucocorticoids are the most commonly used medication but have limited efficacy and present safety concerns. Inhibition of the insulin-like growth factor I receptor (IGF-IR) is a new therapeutic strategy to attenuate the underlying autoimmune pathogenesis of ophthalmopathy. This study was a multicenter, double-masked, randomized, placebo-controlled trial to determine the efficacy and safety of teprotumumab, a human monoclonal antibody inhibitor of IGF-IR, in patients with active, moderate-to-severe ophthalmopathy. 88 patients were randomly assigned to receive placebo or active drug administered intravenously. The primary end point was the response in the study eye. This response was defined as a reduction of 2 points or more in the Clinical Activity Score (scores range from 0 to 7, with a score of ≥3 indicating active thyroid-associated ophthalmopathy) and a reduction of 2 mm or more in proptosis at week 24. Secondary end points, measured as continuous variables, included proptosis, the Clinical Activity Score, and results on the Graves’ ophthalmopathy–specific quality-of-life questionnaire. In the intention-to-
treat population, 29 of 42 patients who received teprotumumab (69%), as compa-
red with 9 of 45 patients who received placebo (20%), had a response at week 24 (P<0.001). Therapeutic effects were rapid; at week 6, a total of 18 of 42 pa-
tients in the teprotumumab group (43%) and 2 of 45 patients in the placebo group (4%) had a response (P<0.001). Differences between the groups in-
creased at subsequent time points. Patients receiving teprotumumab also had a re-
duction in subjective diplopia symptoms that was statistically significant (P<0.001). The only drug-related adverse event was hyperglycemia in patients with diabetes, which was controlled by adjusting diabetic medications.In conclu-
ion, teprotumumab was more effective than placebo in reducing proptosis and the Clinical Activity Score in patients with Graves ophthalmopathy. This study is of high relevance to strabismologists because we do not currently have any med-
ic treatments to treat diplopia due to Graves ophthalmopathy. Of note, the study was funded by the drug manufacturer.

21. OCULOPLASTICS

The value of the Frontalis suspension procedure as a repeat inter-
tervention in Congenital Blepharoptosis.

Özlem Ural, Mehmet C. Mocan, Ugur Erdener J of Ped Ophthalm & Strabis-
mus. 2017;54(5):320-323

The purpose of this retrospective study is to evaluate the therapeutic benefits of frontalis suspension as a repeat intervention in congenital blepharoptosis. Eighty-
four eyes of 77 patients with simple congenital ptosis (44 males and 33 females) were evaluated. The mean ages at diagnosis and first surgery were 6.4 ± 0.6 years (range: 0 to 15 years) and 8.1 ± 0.5 years (range: 1 to 16 years), respec-
tively. The mean follow-up period was 8.4 ± 0.7 years (range: 2 to 29 years).Levator function, margin-reflex distance, and ocular motility data were in-
cluded for each visit. Ptosis was categorized as mild (≤ 2 mm), moderate (> 2 mm and < 4 mm), and severe (≥ 4 mm). According to the clinical algorithm fol-
lowed by the operating surgeon, either modified Fox-Pentagon frontalis suspen-
sion or anterior approach levator resection was used for primary interventions depending on the baseline levator function. Patients who required repeat surgical interventions underwent frontalis suspension. A successful outcome was defined as a postoperative margin-reflex distance of 3 mm or greater at the time of the last postoperative examination. Surgical success was achieved in 61.9% of pa-
tients with single surgery (75.9% for levator resection vs 54.5% for frontalis sus-
pension; P = .06) and in 77.4% of patients following repeated surgeries (93.1% vs 69.1% for patients who initially underwent levator resection vs frontalis sus-
pension, respectively; P = .012). A higher success rate was associated with bet-
ter preoperative levator function (P = .01) and a higher margin-reflex distance (P = .004), and was inversely proportional to ptosis severity (P = .04). The au-
thors suggested that both levator resection and frontalis suspension as initial interventions for congenital ptosis provide satisfactory functional outcomes, but recurrences are to be expected with longer follow-up periods. In cases with recurrence, additional interventions such as frontalis sling offer the opportunity for further improvement and are recommended for optimum outcomes.

Use of the Masterka for complex nasolacrimal duct obstruction in children.

The Masterka stent has been recommended solely for treatment of simple distal membranous nasolacrimal duct obstruction (NLDO). The purpose of this retrospective study was to evaluate the Masterka stent as a primary treatment in complex forms of NLDO, including bony ductal stenosis and proximal and serial membranous obstruction. The medical records of patients who underwent treatment for congenital nasolacrimal duct obstruction with the mono-canalicular Masterka stent were reviewed retrospectively. Both simple and complex forms of NLDO were primarily treated with probing and irrigation, followed by placement of the Masterka stent. A total of 72 eyes (53 patients) were included: 17 cases were simple forms of NLDO; and 55 were complex. Success was achieved in 15 of 17 simple cases (88%) and 39 of 55 complex cases (71%); the overall success rate was 75%. In patients <24 months of age, success rates were 100% for simple and 78% for complex forms. The authors conclude the Masterka stent can be useful in a younger subset of patients with more complex forms of congenital NLDO. A lower success rate is noted in children >2 years of age and complex forms of NLDO, especially those with bony stenosis. Apart from being limited by its retrospective nature and its relatively small sample size, the study failed to demonstrate a comparable success rate to other types of silicone tube intubation in NLDO.

Anatomical characterization of Nasolacrimal Canal Based on Computed Tomography in children with Complex Congenital Nasolacrimal Duct Obstruction.

The purpose of this study was to identify anatomical variations of the nasolacrimal canal in patients with complex congenital nasolacrimal duct obstruction. The authors retrospectively reviewed the computed tomography radiographs of 25 children (17 boys and 8 girls, mean age 60 months, range of 4 to 137 months), with congenital nasolacrimal canal dysplasia who had failed probings. Anomalous development of the nasolacrimal canal was confirmed on computed tomography. Two main types of malformations were observed: fundamental (20 patients) and special (5 patients). In the fundamental type, the upper portion of the
nasolacrimal canal was relatively normal and became significantly stenotic, or even atretic, at the middle and terminal segments. In the special type, the upper portion of the nasolacrimal duct was malformed. Only the special type showed an association with systemic abnormalities. In patients with unilateral fundamental type malformation (11 patients), the transverse and anteroposterior diameters of the upper segment of the nasolacrimal canal on the affected side were significantly larger than that of the normal side ($P = .000$). The height of the nasolacrimal canal on the normal side was significantly larger than that of the affected side ($P = .000$). The authors conclude that computed tomography is useful for delineation of anatomical characteristics of the nasolacrimal canal and to diagnose nasolacrimal canal malformation.

22. INFECTIONS

Visual impairment in children with congenital Zika syndrome.
Ventura, L. O., Ventura, C. V., Lawrence, L., van der Linden, V., et al.

The goal of this cross-sectional study was to describe the visual impairment associated with ocular and neurological abnormalities in a cohort of children with congenital Zika syndrome (CZS). It included infants with microcephaly born in Pernambuco, Brazil, from May to December 2015. Immunoglobulin M antibody capture enzyme-linked immunosorbent assay for the Zika virus on the cerebrospinal fluid samples was positive for all infants. Clinical evaluation consisted of comprehensive ophthalmologic examination including visual acuity (Teller Acuity Cards II), visual function assessment, visual developmental milestone, neurologic examination, and neuroimaging. A total of 32 infants (18 males [56%]) were included. Mean age at examination was 5.7 +/- 0.9 months (range, 4-7 months) were included in the study. Visual impairment was detected in all 32 participants. Retinal and/or optic nerve findings were observed in 14 patients (44%). There was no statistical difference between the patients with ocular findings and those without ($P = 0.180$). Nystagmus was identified in 28% of infants; strabismus, in 75%. All patients (100%) demonstrated neurological and neuroimaging abnormalities; 3 (9%) presented with late-onset of microcephaly. Despite the relatively small sample size, and the presence of motor impairment in certain cases, which may have limited the child’s response for visual function testing, this is a well-designed study. The authors conclude that children with CZS demonstrated visual impairment regardless of retina and/or optic nerve abnormalities. This finding suggests that cortical/cerebral visual impairment may be the most common cause of blindness identified in children with CZS.

The visual system in infants with microcephaly related to presumed congenital Zika syndrome.
The purpose of this cross-sectional study was to describe and analyze ocular features in infants with microcephaly due to presumed congenital Zika syndrome. Ophthalmologic evaluation, including indirect ophthalmoscopy and eye fundus imaging, visual acuity testing with Teller Acuity Cards, and strabismus assessment were performed in infants with microcephaly at a nongovernmental organization clinic for visually disabled children. RESULTS: A total of 70 infants with microcephaly were referred to the clinic. Of these, 25 (mean age, 3 months; 14 males) had ophthalmologic changes: 18 (26%) had intraocular abnormalities, including macular chorio-retinal atrophy, mottled retinal pigment epithelium and optic nerve pallor; 7 patients (10%) had strabismus or nystagmus without intraocular abnormalities. Visual acuity was below normal range in all 11 infants tested. The authors conclude that ophthalmologic abnormalities are frequent in presumed congenital Zika syndrome. Macular circumscribed chorio-retinal atrophy, focal mottled retinal pigment epithelium, optic nerve pallor, early-onset strabismus, nystagmus and low visual acuity were common ophthalmological features in infants with microcephaly due to presumed congenital Zika syndrome. The main limitation of this study is the lack of laboratory evidence with specific serological testing to confirm Zika virus. Longer ophthalmologic follow-up with retinal imaging and visual development assessment are needed for further understanding of the CZS the consequences for visual performance.

Pediatric blepharokeratoconjunctivitis: is there a ‘right’ treatment?


The author reviews the diagnosis and treatment options for blepharoconjunctivitis (BKC) in children. BKC should be suspected in patients with frequent, multiple chalazia, recurrent photophobia, redness and foreign body sensation. Clinically, patients may have eyelash flaking, collarettes, along with posterior blepharitis with inspissated Meibomian glands, telangiectasia, and irregular lid margins. The cornea may have pannus formation, SEI and punctate keratopathy which may be bilateral and asymmetrical. Pediatric ocular rosacea and Demodex should be suspected in cases of chronic BKC. Treatment regimens vary but usually include hot compresses to assist in melting glandular secretions followed by vigorous massage to express gland material and eyelid scrubs with baby shampoo. Tea tree oil may be helpful in cases although there are no pediatric studies about this. Use of topical lubrication to improve tear film disruption as well as bacitracin and erythromycin ointment applied to lid margins at bedtime may help limit colonization of bacterial lid flora. In severe cases topical steroids may be required and in some cases Restasis may be used as a steroid sparing agent. In adults, oral antibiotics can be effective. Due to issues with dentition in children erythromycin may be used for severe BKC at doses between 12.5-40 mg/kg/day divided bid.
and continued up to 12 months. Oral azithromycin at 5mg/kg/day divided bid has also been used although one must be aware of the GI side-effects and reversible hearing damage. The authors comment on the lack of RCTs for BKC in children with most studies cited either being adult studies or small case series.

**Medical management of blepharoconjunctivitis in Children: A Delphi Consensus.**

The purpose of this study is to describe a pragmatic approach to the medical management of blepharoconjunctivitis in children, based on published evidence and clinical experience. The authors used the Delphi consensus method to explore the preferred management patterns of four senior clinicians at one institution to reach agreement on indications and dosage schedules for commonly used treatments. Four iterations were created, with electronic questionnaires distributed via an online survey platform. Initial questions were based on recent systematic reviews and clinical experience. After each round, a facilitator summarized the responses and fed these back to the expert participants, together with an invitation to complete the next round of questions. Typical and specific eyelid, corneal, and conjunctival disease features influenced management decisions, and treatments were targeted toward specific findings in these tissues rather than to overall disease severity. Active keratitis was considered the main indication for high potency steroids, systemic antibiotics and possibly systemic immunomodulators. Other indications for systemic antibiotics were chronic active blepharitis and recurrent troublesome chalazia. Oral antibiotics were used for their anti-inflammatory and antimicrobial properties. There was little agreement on the role of dietary modifications, topical lubricants, and preference for oral or topical antibiotics. The authors presented a pragmatic treatment algorithm to assist in the management of blepharoconjunctivitis in children based on evidence and clinical experience. Nevertheless, further work needs to be done in order to evaluate the efficacy of this approach in the management of blepharoconjunctivitis.

**Video Game Vision Syndrome: A New Clinical Picture in Children?**
The purpose of this observational, cross-sectional study is to explore the possible relationship between exposure to video games/electronic screens and visual issues in children between 3 and 10 years of age. Three hundred twenty children (n1=159 boys, n2=161 girls) with a mean age of 6.9 years +/- 2 years were recruited at an outpatient unit accredited by the Italian Regional Health Service. Two groups of children were examined according to the average amount of time spent playing video games daily: children who played video games for less than 30 minutes per day and not every day (control group) and children who played video games for 30 minutes or more every day (video game group). Both groups were then divided into two subgroups: children using other types of electronic screens (eg, televisions, computers, tablets, and smartphones) for less than 3 hours daily (low electronic use subgroup) and children using other types of electronic screens for 3 hours or more per day (high electronic use subgroup). All patients underwent both ophthalmological and orthoptic examinations including ocular motility, identification of the dominant eye using the Dolman method, cover test for distance and near vision using the Lang Fixation Cube (LANGSTEREOTEST AG, Kusnacht, Switzerland) as a target for near fixation, and the 4 prism diopter base-out test. Stereopsis was tested with Lang-Stereotests I and II (LANG STEREOTEST AG). Refraction was assessed using the KR8100P autorefractometer (Topcon Corporation, Tokyo, Japan) by taking at least 5 measurements for each eye before the evaluation of subjective monocular visual acuity with optotypes at a distance of 3 m in both non-cycloplegic and cycloplegic conditions. A questionnaire was also used at the end of the ophthalmologic examination in order to collect the following information from the parents: estimated average time spent playing video games, estimated average daily time spent using other types of electronic screens and any asthenopic symptoms (such as burning, blurred vision, ocular dryness, tearing, eye strain, eye ache, transient diplopia, dizziness, headache, and eyelid tic). The authors concluded that asthenopia (especially headaches, eyelid tic, transient diplopia, and dizziness), absence of fine stereopsis, and refractive errors were statistically more frequent in children in the video group. This study is limited by its methodology: no baseline data prior to the use of video games were obtained. Also data considering estimated playing time and parent-reported symptoms could have been biased by the perceptions of parents. Although the authors conclude that the constant use of video games in children may have an adverse effect on their visual system, large prospective studies will be needed in the future in order to investigate in depth these interesting hypotheses.

Sensorimotor outcomes in children with prenatal exposure to methadone.

The aim of this retrospective study was to report the presentation and characteristics of strabismus in children with prenatal methadone exposure. The medical records of children with prenatal methadone exposure were retrospectively reviewed. Those who were evaluated by pediatric ophthalmology were included.
Information on the timing and types of prenatal exposure by trimester of pregnancy was then collected from the patients' mothers' charts. The children's perinatal histories and ophthalmologic findings were collected from their pediatric clinic charts and ophthalmology clinic charts, respectively. A total of 210 children with prenatal methadone exposure were identified, of whom 32 (15.2%) underwent eye examinations and 21 (10%) had strabismus. Five patients had esodeviations, with a mean age of onset of 11.6 months; 16 had exodeviations, with a mean age of onset of 6.8 months. Three patients with strabismus were born prematurely, and 2 had intracranial disease. Two patients underwent strabismus surgery. The authors concluded that the incidence of strabismus in patients with prenatal methadone exposure was higher than in the general population (10% vs 3%-4%). Intermittent exotropia was the most common type of strabismus and presented earlier than in the general population, with no association with other systemic disease. Prenatal exposure to methadone was likely confounded by exposure to other substances, environmental factors, and genetics. The study essentially validated previous data. Poor compliance with follow-up reduced the power of the study and limited its sample size.

Incidental Findings on Brain Imaging in the General Pediatric Population.


This study of 3966 children (mean age, 10.1 years; range, 8.6 to 11.9) reports the prevalence of incidental findings on brain magnetic resonance imaging (MRI) in a large, single-center study involving a general pediatric population. At least one incidental finding was present in 25.6% of the children (95% confidence interval [CI], 24.2 to 27.0), although the prevalence of findings requiring clinical follow-up was only 0.43% (95% CI, 0.26 to 0.70). The most common findings were cysts of the pineal gland (in 665 children; 16.8%; 95% CI, 15.6 to 18.0), arachnoid cysts (in 86; 2.17%; 95% CI, 1.75 to 2.68), and developmental venous anomalies (in 63; 1.59%; 95% CI, 0.12 to 2.04). Common normal variants were mega cisterna magna (in 104 children; 2.62%, 95% CI, 2.16-3.18) and cavum septum pellucidum (in 79, 1.99%, 95% CI, 1.59-2.49). Among less frequent findings were Chiari I malformations (in 25 children; 0.63%, 95% CI, 0.42 to 0.94) and subependymal heterotopia (in 19; 0.48%; 95% CI, 0.30 to 0.76). This study will aid in counseling the families of patients who are found to have incidental findings on brain MRI.

Childhood-Onset Leber Hereditary Optic Neuropathy.


Leber hereditary optic neuropathy (LHON) (OMIM 535000) is a mitochondrial disorder that classically presents with acute or subacute bilateral loss of central
vision in young adult men. Childhood-onset disease is relatively rare and less than 10% of patients were 12 years old or younger at the time of diagnosis in previously published case series. Although there are limited data on this important patient subgroup, the phenotype seems distinct from classical adult-onset LHON with atypical patterns of vision loss and a better visual prognosis as reported previously. This study describes the clinical and molecular genetic features observed in this specific LHON subgroup. The retrospective study consisted of a UK pediatric LHON cohort of 27 patients and 69 additional cases identified from a systematic review of the literature. Patients were included if visual loss occurred at the age of 12 years or younger with a confirmed pathogenic mitochondrial DNA mutation: m.3460G>A, m.11778G>A or m.14484T>C. In the UK pediatric LHON cohort, three patterns of visual loss and progression were observed: (1) classical acute (17/27, 63%); (2) slowly progressive (4/27, 15%); and (3) insidious or subclinical (6/27, 22%). Diagnostic delays of 3-15 years occurred in children with an insidious mode of onset. Spontaneous visual recovery was more common in patients carrying the m.3460G>A and m.14484T>C mutations compared with the m.11778G>A mutation. Based on a meta-analysis of 67 patients with available visual acuity data, 26 (39%) patients achieved a final best-corrected visual acuity (BCVA) ≥0.5 Snellen decimal in at least one eye, whereas 13 (19%) patients had a final BCVA <0.05 in their better seeing eye. Although childhood-onset LHON carries a relatively better visual prognosis, approximately 1 in 5 patients will remain within the visual acuity criteria for legal blindness in the UK. In conclusion, childhood-onset LHON represents a distinct phenotypical subgroup characterized by a more varied clinical evolution and a more favorable visual prognosis compared with classical adult LHON. Importantly, children do not always develop acute or subacute visual symptoms and a high index of suspicion is required in children presenting with unexplained subnormal vision and optic disc pallor to avoid potentially long diagnostic delays.

**Pupillary Manifestations of Marfan syndrome: From the Marfan Eye Consortium of Chicago.**

Marfan syndrome (MFS) is a genetic disorder that affects multiple organ systems, including the eye. The most common ocular manifestations include ectopia lentis and retinal detachment. The current literature qualitatively cites that MFS patients have miotic or "poorly dilating" pupils. This study was the first to quantitatively assess pupillary function in MFS patients. 57 eyes from 29 MFS patients, 36 eyes from 18 pediatric age- and gender-matched controls, and 44 eyes from 22 adult age-matched controls were measured in a clinic-based cross sectional study. Pupillometry data were measured in scotopic conditions using the handheld NeurOptics PLR-200™ Pupillometer (NeurOptics, Irvine, CA, USA). Data obtained with the pupillometer were maximum and minimum diameter, constriction percentage, latency, average and maximum constriction velocities, average dilation velocity, and 75% recovery time (T75). Pediatric patients with MFS had significantly slower average constriction velocity measurements (β = 0.65,
maximum constriction velocity measurements (β = 0.51, p = 0.0150) and average dilation velocity measurements (β = -0.19, p = 0.0029) compared to control patients. In the adult cohort, results indicated significantly slower average dilation velocity measurements (β = -0.13, p = 0.0077) compared to controls. Our data highlight pupillary parameters within a population of MFS patients under scotopic conditions. Constriction and dilation velocities were slower in the pediatric MFS patients compared to age- and gender-matched controls, and dilation velocities were slower in the adult MFS patients compared to age-matched controls. These findings, for the first time, quantitatively demonstrated differences in pupillary function in patients with MFS. The authors hypothesize that myopathy in pupil constrictors and dilators may explain the statistically significant decreases in constriction and dilation velocity seen in this population.

24. UVEITIS/ SYSTEMIC

Risk Factors for the Development of Cataract in Children with Uveitis.

Cataract formation is the most common complication of pediatric uveitis and occurs in approximately 35% of patients with juvenile idiopathic arthritis (JIA)-associated uveitis. Cataracts can form in these patients due to inflammation or can be due to treatment of the uveitis (steroids). While the risk factors for the development of cataracts in JIA-associated uveitis have been described, there is no previous study looking at risk factors in children with uveitis of any etiology. This study is a cohort study of 247 eyes of 140 children with uveitis. The authors evaluated the demographic, clinical, and treatment data of these patients. The main outcome of the study was cataract formation. The authors found a prevalence of cataract of 44.2% in their cohort. The highest prevalence was found in the patients with panuveitis (77.1%), chronic anterior uveitis (48.3%), and intermediate uveitis (48.0%). The authors estimate that 69% of patients develop uveitis related cataract with time. The main risk factors included the number of uveitis flares per years, cystoid macular edema, posterior synechiae at presentation, and the use of injected steroids. Topical and systemic steroids were not found to be significant risk factors. The rate of cataract formation in this study was higher than those looking just at patients with JIA-associated uveitis and the authors hypothesize that this is due to the screening programs for children with JIA and earlier diagnosis. The data also suggest that inflammation is a stronger risk factor than steroid use and thus inflammation may contribute more to the cataract formation than the treatment of the uveitis. While the retrospective design is a limitation, this is a large cohort of patients with a long duration of follow up. The authors
conclude that disease control should continue to be the primary goal when treating uveitis.

**Adalimumab plus Methotrexate for Uveitis in Juvenile Idiopathic Arthritis.**

Adalimumab, a fully human anti–tumor necrosis factor α monoclonal antibody, is effective in the treatment of juvenile idiopathic arthritis (JIA). This study tested the efficacy of adalimumab in the treatment of JIA-associated uveitis. The study was a multicenter, double-blind, randomized, placebo-controlled trial of adalimumab in children and adolescents 2 years of age or older who had active JIA-associated uveitis. Patients who were taking a stable dose of methotrexate were randomly assigned in a 2:1 ratio to receive either adalimumab (at a dose of 20 mg or 40 mg, according to body weight) or placebo, administered subcutaneously every 2 weeks. Patients continued the trial regimen until treatment failure or until 18 months had elapsed. They were followed for up to 2 years after randomization. The primary end point was the time to treatment failure, defined according to a multicomponent intraocular inflammation score.

The trial was stopped early owing to a strong beneficial effect in the adalimumab group. There were 16 treatment failures in 60 patients (27%) in the adalimumab group versus 18 treatment failures in 30 patients (60%) in the placebo group (hazard ratio, 0.25; 95% confidence interval [CI], 0.12 to 0.49; P<0.0001). Patients who received adalimumab had a much higher incidence of adverse events and serious adverse events than those who received placebo. The most common adverse events in the adalimumab group were minor infections, respiratory disorders, and gastrointestinal disorders. In conclusion, adalimumab therapy controlled inflammation and was associated with a lower rate of treatment failure than placebo among children and adolescents with active JIA-associated uveitis who were taking a stable dose of methotrexate.

This study is important to pediatric ophthalmologists in offering high quality evidence that adalimumab is effective in treating JIA-associated uveitis that is refractory to methotrexate, as use of adalimumab in this setting has already become “standard clinical practice.” We do not have high quality evidence regarding how adalimumab compares to other TNF alpha inhibitors like infliximab, however.

**25. PRACTICE MANAGEMENT/ HEALTH CARE SYSTEM**

**Pediatric ophthalmology and strabismus fellowship Match outcomes, 2000-2015.**
Dotan, G., Karr, D. J. and Levin, A. V. *JAAPOS* June 2017; 21(3): 181.e181-181.e188.
The purpose of this retrospective study was to analyze trends in US pediatric ophthalmology and strabismus (PO&S) Match over the last 16 years. The authors reviewed the PO&S Match outcomes from 2000 to 2015, evaluating the number of participating programs, positions offered, and match rate, comparing it with other subspecialties, and analyzing results of US graduates versus international medical graduates (IMGs). A survey of PO&S program directors explored exposure to PO&S, policies on acceptance of IMGs, fellowship gross salary, job opportunities, and fellow placement after training. The PO&S matching rate varied yearly but was consistently lower compared to other subspecialties. The supply of fellowship positions was always higher than the demand, with an annual average of 32% unmatched positions, ranging from a low of 12% in the year 2010 to a high of 52% unmatched positions in 2004. In 2013 to 2015, 31% (from 24% to 38%) of PO&S matched fellows were IMGs, which is significantly more compared to all other ophthalmic subspecialties combined during the same time period (mean, 15%; from 15% to 16%; P < 0.001) and a significant increase from the 3 years before (mean, 20%; from 12% to 26%; P = 0.041). The survey revealed that academic and clinical exposure of residents to PO&S usually begins during the first year of residency (PGY2). Residents spend on average 16 weeks of their training in PO&S, often with more than one faculty member. The authors conclude that the interest in PO&S remains lower than other ophthalmology subspecialties despite an apparent national need for trained pediatric ophthalmologists.

The study could only reflect the information that was available through the Match, even though the actual number of fellows is higher. Another limitation of the study is that the survey response rate was only 73% and does not reflect all programs. Despite these limitations, this interesting and well-written report raises an important issue that needs to be addressed nationally. Some solutions are offered in the discussion, including the need for improved reimbursement and to enable PO&S trained IMG to remain in the United States.