Department of Ophthalmology and Vision Sciences
University of Toronto

Sixty-Third Annual Research Day
and
Fortieth Clement McCulloch Lecture

Virtual Session I - April 27th 2021
Virtual Session II - May 4th 2021
Virtual Session III - May 11th 2021

7:00 PM – 9:00 PM

Meeting Chairperson

Matthew Schlenker, MD, MSc, FRCSC
Assistant Professor
Department of Ophthalmology and Vision Sciences
University of Toronto

UHN - Toronto Western Hospital
Kensington Eye Institute
Trillium Health Partners
# PROGRAM

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00-7:03 PM</td>
<td>Department Chair’s Welcome</td>
</tr>
<tr>
<td></td>
<td>Dr. Sherif El-Defrawy</td>
</tr>
<tr>
<td>7:03-7:05 PM</td>
<td>Annual Ophthalmology Research Day Chair Welcome</td>
</tr>
<tr>
<td></td>
<td>Dr. Matthew Schlenker</td>
</tr>
</tbody>
</table>

*F= Fellow, R=Resident, M=Medical Student, G=Graduate Student, VS=VSRP (Vision Science Research Program) Student, RF= Research Fellow, U=Undergraduate Student*

## Virtual Session II

**April 27/ May 4/ May 11  
(7:00 – 9:00 PM)**

<table>
<thead>
<tr>
<th>Format:</th>
<th>Session Panelist: Dr. Radha Kohly</th>
<th>9 min. Presentation + 3 min. Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:05 – 7:14 PM</td>
<td>A Comparison of the Toronto Artificial Intelligence Model for Intraocular Lens Power Calculation to 12 Preoperative Cataract Formulas: A Preliminary Validation Study</td>
<td>Austin Pereira (R)</td>
</tr>
<tr>
<td>7:17 – 7:26 PM</td>
<td>Improved Survival of Micro-Premature Infants: Influence on Retinopathy of Prematurity Development, Presentation and Treatment</td>
<td>Parampal Grewal (F)</td>
</tr>
<tr>
<td>7:29 – 7:38 PM</td>
<td>A Prospective Randomized Clinical Trial Comparing Nepafenac, Intravitreal Triamcinolone and No Adjuvant Therapy for Epiretinal Membrane</td>
<td>Mohammed Alfalah (R)</td>
</tr>
<tr>
<td>7:41 – 7:50 PM</td>
<td>The function of retinal guidance molecule ephrin-A2 in visual map development in the midbrain</td>
<td>James Dunbar (VS)</td>
</tr>
<tr>
<td>7:53 – 8:01 PM</td>
<td>Incidence of Outer Retinal Folds following Pneumatic Retinopexy vs Pars Plana Vitrectomy for Primary Rhegmatogenous Retinal Detachment Repair: Post-Hoc Analysis from PIVOT trial.</td>
<td>Wei Wei Lee (F)</td>
</tr>
</tbody>
</table>

8:05 – 8:25 PM  | Applications of deep learning in ophthalmology | Guest Speaker Dr. Aaron Lee |

8:25 – 8:55 PM  | Q & A and Discussion |

8:55 – 9:00 PM  | Closing Session II |
ABSTRACTS FOR ORAL PRESENTATIONS

Virtual Session II

May 4th, 2021
A Comparison of the Toronto Artificial Intelligence Model for Intraocular Lens Power Calculation to 12 Preoperative Cataract Formulas: A Preliminary Validation Study

Austin Pereira MD MEng1, Marko Popovic MD MPH(C)1, Yusuf Ahmed MD(C)2, Aaron Hao Tan MASc PhD(C)3, Luqmaan Moolla MEng MD(C)2, John C. Lloyd MD FRCSC1,4,5, Sherif El-Defrawy MD FRCSC1,5, Matthew B. Schlenker MD SM FRCSC1,5

1 Department of Ophthalmology and Vision Sciences, University of Toronto, 340 College Street Unit 400, Toronto, Ontario, Canada, M5T 3A9
2 Faculty of Medicine, University of Toronto, 1 King’s College Circle, Toronto, Ontario, Canada, M5S 1A8
3 Faculty of Applied Science and Engineering, University of Toronto, Galbraith Building, Toronto, Ontario, M5S 1A4
4 Sunnybrook Health Sciences Centre, 2075 Bayview Avenue, Toronto, Ontario, Canada, M4N 3M5
5 Kensington Eye Institute, 340 College Street Unit 501, Toronto, Ontario, Canada, M5T 3A9

Purpose: Artificial intelligence (AI) regression models using trained machine learning has been postulated to improve refractive predictions in cataract surgery cases with extreme biometric measurements. The purpose of this study was to compare the performance of a novel deep learning neural network, the Toronto AI Intraocular Lens (IOL) Model, to 12 currently available IOL power calculations.

Methods: In this retrospective consecutive case series, cataract extraction and IOL implantation cases from four surgical centers in Toronto, Canada between January 2015 – July 2017 were considered for inclusion. The Toronto AI IOL model was developed using the PyTorch open-source machine learning framework. This model was trained with preoperative biometric parameters, age, sex, and the known 1-month postoperative spherical equivalent. Overall, 1743 eyes cataract cases trained the AI model, and the remaining 747 cases were included in the testing analysis. Refractive predictions from each calculation were compared to the observed 1-month postoperative spherical equivalent for each cataract case to determine the refractive error for the 13 formula cohorts. Biometric parameters were obtained using the IOLMaster 500. Subgroup analysis stratified eyes into short (≤22.5mm), intermediate (22.5mm-25.5mm) and long (≥25.5mm) axial length (AL) cohorts. The primary outcome was the percentage of cases within ±0.50D of refractive error.

Results: Formulas with the highest percentage of eyes within ±0.50D of refractive error, in decreasing order, were: Toronto AI IOL model (81.5%), Kane (77.7%), Barrett Universal II (77.4%), EVO (76.6%), T2 (76.4%), Super (75.9%), Holladay 1 (75.4%), Hill-RBF 2.0 (74.7%), SRK/T (72.6%), Hoffer Q (72.5%), Haigis (71.7%), Olsen (67.4%) and Holladay 2 (67.3%). For short AL eyes, the Toronto AI IOL model was most accurate (n=96, 83.3% within ±0.50D) followed by Holladay 1 (78.3%). For long AL eyes, the novel AI model was most accurate (n=116, 78.5% within ±0.50D) followed by the Barrett Universal II formula (76.7%). The AI model led to a significantly higher accuracy at short and long AL and anterior chamber depth cases compared to all formulas, except for Kane and Barrett Universal II (p-value: <0.001-0.046).

Conclusions: Using a novel deep learning neural network, the Toronto AI IOL model was the most accurate preoperative IOL power calculation formula compared to 12 currently available IOL calculations. The AI model maintained accuracy at extremely short and long AL cases, whereas alternative calculations lost predictive performance.

Acknowledgements: None. Financial Support: This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors. Declarations of Interest: The authors have no conflicts of interest relevant to this study.
Improved Survival of Micro-Premature Infants: Influence on Retinopathy of Prematurity Development, Presentation and Treatment

Parampal S. Grewal,1 Kenneth T. Eng,1 Avner Hostovsky,1 Amrit Rai,1 Hatim Batawi,1 Alaa Alali,1 Peter J. Kertes,1 Asaph Rolnitsky2

1Department of Ophthalmology and Vision Sciences, University of Toronto
2Neonatal-Perinatal Medicine, Department of Paediatrics, University of Toronto

Background: Advancing neonatal care has allowed improved survival of micro-premature infants (< 26 weeks gestational age, GA). There are limited reports of the characteristics of retinopathy of prematurity (ROP) in this group, particularly those born less than 24 weeks GA.

Purpose: To describe the risk and nature of ROP in the most premature infants.

Design, Participants & Methods: Retrospective analysis of prospectively collected data from infants born at 22-26 weeks GA at a high-risk (level 3) neonatal intensive care unit over a 5 year period.

Results: A total of 574 infants were identified, of whom 415 survived to discharge (72.3%). Detailed ROP exam results were available for 294 of those infants who survived (70.8%). Forty infants were born between 22-23 weeks GA (group A) and 254 were born between 24-26 weeks GA (group B). Group A infants were more likely to develop ROP (90.0% vs. 48.6%, p < 0.01) and more likely to develop treatment requiring ROP (27.5% vs. 4.7%, p < 0.01) than group B infants. Group A infants developed ROP at an earlier age (32+6 weeks vs. 33+3 weeks, p = 0.02); however, there was no difference in the corrected gestational age of peak severity of ROP (35+2 weeks vs. 34+5 weeks, p = 0.357). Amongst those requiring treatment, group A infants trended to require treatment earlier (35+0 weeks vs. 36+0 weeks, p = 0.057). Multivariate analysis found the main risk factors for developing treatment-requiring ROP were: GA (p < 0.01), severe intraventricular hemorrhage (p < 0.01), patent ductus arteriosus (p = 0.03) and pneumothorax (p < 0.01). Birth weight was not significant on multivariate analysis (p = 0.129). During the study period, survival rates of infants born at 23 weeks GA earlier improved from 22% in 2014 to 51% in 2018 (R² = 0.652).

Conclusions: Survival rates of micro-premature infants are improving and the most premature infants, born at 22-23 weeks GA, are more likely to develop ROP and have a high risk of disease requiring treatment. This may lead to a shift in the population of infants requiring treatment for ROP, though existing screening criteria appear to adequately capture disease.

Disclosure Statement: The authors have no relevant financial disclosures or conflict of interest.
A Prospective Randomized Clinical Trial Comparing Nepafenac, Intravitreal Triamcinolone and No Adjuvant Therapy for Epiretinal Membrane

Efrem D. Mandelcorn¹, Mohammed Al-Falah¹,², Lei Di Zhao³, Peter Kertes¹,⁴, Robert Devenyi¹, Wai-Ching Lam¹

¹Department of Ophthalmology and Vision Sciences, University of Toronto, Canada  
²College of Medicine, King Faisal University, Saudi Arabia  
³Division of Ophthalmology, McMaster University, Canada  
⁴The John and Liz Tory Eye Centre, Sunnybrook Health Sciences Centre, Canada

Objective: To compare the efficacy of topical Nepafenac 0.1% versus intravitreal triamcinolone acetonide (IVTA) at the conclusion of vitrectomy surgery versus no adjuvant therapy (NAT) in improving macular morphology post-operatively in patients undergoing vitrectomy for epiretinal membrane (ERM), as measured by optical coherence tomography (OCT) imaging and best corrected visual acuity (BCVA).

Design: Prospective randomized clinical trial

Methods: Setting: Multi-centre

80 patients scheduled to undergo vitrectomy surgery for idiopathic ERM were randomized to receive either IVTA (4mg/0.1cc) at the end of surgery, topical nepafenac sodium 0.1% TID for one month post-operation, or no adjuvant treatment (NAT). OCT imaging, best-corrected visual acuity and intraocular pressure (IOP) were measured before surgery, and one and two months post-operation.

Results: Although all three groups showed reduction in macular thickness post-operation, the NAT group showed the most improvement, with a reduction of 136.18±29.84μm at two months. There was no statistically significant difference in macular thickness between the groups at each time point, p= 0.59. The NAT group also had the best recovery in BCVA with an improvement of 0.207 logMAR (10.35 letters) at two months post-operation. There was no statistically significant difference in BCVA between the groups, p=0.06. There was statistically significant difference in the IOP between the three groups, p=0.04. The IVTA group had the highest rise in average IOP at both one and two months post-operation (2.72 and 1.58 mmHg, respectively).

Conclusion: Our study data suggests there was no advantage in the use of topical nepafenac or IVTA for post-vitrectomy ERM surgery.

Trial Registration: This trial was approved by Health Canada and registered under a control number of 126746.

Financial Disclosure: None
The function of retinal guidance molecule ephrin-A2 in visual map development in the midbrain

James Dunbar 1, Kyle Cheung 2, Michael Reber, PhD 1,2

1Laboratory Medicine and Pathobiology, University of Toronto
2Krembil Discovery Tower, University Health Network

The Superior Colliculus (SC) is a multilayered midbrain structure and a major hub for multisensory processing. It primarily receives inputs from visual, auditory and somatosensory modalities, and is a primary hub for sensory integration. During perinatal development, visual inputs reach the superficial layers from retinal ganglion cells (RGCs) in the eye (retino-collicular projections) and from layer 5 neurons in V1 cortex (cortico-collicular projections). These two projections must be aligned and in register for efficient detection of stimuli. The molecular mechanisms controlling the formation and alignment of visual maps is a major research topic in Neurobiology. Multiple hypotheses have been raised about the development of these maps – some contradictory – leaving the question open for debate. The key molecular players controlling visual map formation and alignment are Eph tyrosine kinase receptors and their membrane-bound ligands – ephrins (efn). They both present a complex expression pattern in ganglion cells of the retina, the SC, and V1 made of complementary receptor/ligand gradients. Constitutive knock-out approaches have not been sufficiently informative to gain insights into the nuanced roles of individual Ephs and efns, therefore cell-specific strategies for gene conditional knockout must be employed. My laboratory has developed two new Isl2-driven Cre lines that I have begun characterizing and validating using the Cre-reporter mouse strain Ai9. I will use these newly engineered lines to selectively ablate the efna2 ligand from a specific subset of RGCs. The specific ablation of efna2 in Isl2-expressing RGCs will cause an oscillatory gradient of the retinal efnas. Previous experimental work in our lab together with computational modelling suggest that graded retinal efna ligands are transported to the SC during retino-collicular mapping, where they control the alignment of V1 cortical projections. However, it is unknown which graded efna ligands – Efna2, Efna5, or both – control the process.

To investigate this, I will (1) characterize retinal efnas gradients in Isl2Cre-GFP x efna2fl/fl mutant animals, and (2) analyze the formation and alignment of retino- & cortico-collicular maps during development. To date, I have developed and applied laboratory and computational techniques to quantify the expression profiles of genes involved in visual map formation, which are generalizable for other receptors and tissues of interest.

Figure 1: Simulated gradient of Efna2 across the Temporal-Nasal Axis in WT (left) and Isl2Cre-EF,T, Efna2 F/F (center), from a theoretical retina (right). Distributions generated using \[ [RNA] = Y_0 \times e^{k\text{(Position)}} \pm 30, \] where \( Y_0 = 41.15 \) & \( k = 0.2407 \). Position denotes location along T-N Axis. Each Isl2+ cell (yellow) was chosen randomly. Grey bars denote an estimation of the measured Efna2 gradient if modeled as a smooth curve.
Incidence of Outer Retinal Folds following Pneumatic Retinopexy vs Pars Plana Vitrectomy for Primary Rhegmatogenous Retinal Detachment Repair: Post-Hoc Analysis from PIVOT

Wei Wei Lee MD¹, Aditya Bansal MD¹, Srinivas R Sadda MD², David Sarraf MD³, Alan R Berger MD¹, David T Wong MD¹, Filiberto Altomare MD¹, Louis R Giovedoni MD¹, Roxane J Hiller, MD⁴, Rajeev H Muni, MD¹

¹Department of Ophthalmology and Vision Sciences, University of Toronto, Toronto, Canada
²Department of Ophthalmology, Doheny Eye Institute, Los Angeles, CA, USA
³Department of Ophthalmology, David Geffen School of Medicine, UCLA, Los Angeles, CA, USA
⁴Department of Ophthalmology, Newcastle Eye Centre, Royal Victoria Infirmary, Newcastle upon Tyne, UK

Purpose: The purpose of this study is to investigate the incidence of outer retinal folds (ORF) in pneumatic retinopexy (PnR) vs pars plana vitrectomy (PPV) and perform a detailed assessment of ORF morphology on enface and cross-sectional spectral-domain optical coherence tomography (SD-OCT) following rhegmatogenous retinal detachment (RRD) repair. We also set out to assess the correlation of various morphological features of the ORFs with functional outcomes.

Study Design: Randomized controlled trial

Methods: This study is a post-hoc analysis of participants from the PIVOT randomized controlled trial (PIVOT) comparing two surgical interventions (PnR vs PPV) for the management of primary RRD. The incidence and morphological features of the ORFs were assessed on OCT at 1 month post-operatively. Quantitative assessment of various morphological features of the ORFs was performed with Image J. Objective metamorphopsia was measured with the MCHARTS and ETDRS visual acuity was assessed at 1 year.

Results: Eighty-eight patients of the 176 participants from the PIVOT randomized controlled had macula-off RRD. Eighty-three of the macula-off eyes had a Month 1 post-operative OCT scan that was gradable. 42 patients (95.5%) in the PnR group and 41 patients (93.2%) were included in this study. Baseline characteristics were similar between the groups. The incidence of ORF formation was 34.1% (14/41) in the PPV group and 14.3% (6/42) in the PnR group (p=0.034). ETDRS letter score was worse in patients with ORFs compared to those without ORF formation by 9.4 letters at 1 year (65.7 ± 6.6 letters versus 75.1 ± 1.4 letters, p=0.047). The horizontal and vertical metamorphopsia scores were similar in patients with folds and those without folds (0.35 ± 0.12 versus 0.29 ± 0.07, p= 0.69) and (0.25 ± 0.07 versus 0.29 ±0.07, p = 0.60) respectively. There was a significant negative correlation between the distance of the ORF from the fovea with the vertical metamorphopsia score (r=−0.507, p=0.045).

Conclusions: Outer retinal folds occur more often in eyes undergoing PPV compared to PnR. The presence of outer retinal folds was significantly associated with worse ETDRS visual acuity at 1 year. There was a negative correlation between the distance of the ORF from the fovea and vertical metamorphopsia. The closer the ORFs were to the fovea, the greater the vertical metamorphopsia score.
Guest Lecture
8:05 – 8:25 PM

Applications of Deep Learning in Ophthalmology

Dr. Aaron Y. Lee  MD MSCI

Abstract: The advent of deep learning has revolutionized the field of artificial intelligence. This talk will give background into core concepts and discuss recent applications into clinical ophthalmology.