

Ophthalmology Update

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Ruti Sella, M.D.

Research and New Technology Aid in Improving IOL Prediction Accuracy, Patient Outcomes

Expectations after cataract surgery can be high. Patients anticipate better vision and typically expect to decrease their dependency on glasses. With these expectations, there is a constant call for improvement in intraocular lens (IOL) power calculation accuracy.

“A patient’s quality of life can be tremendously improved if they no longer require glasses for all daily tasks,” says Ruti Sella, M.D., an ophthalmologist and researcher at Mayo Clinic in Rochester, Minnesota. To achieve improved accuracy in an increased number of patients — while also improving accuracy in patients with less common eye measurements — the focus shifts to improving the prediction accuracy of existing formulas by adopting new technologies.

“Harnessing the use of AI to build better formulas that can learn and develop with time and additional data is a key step in moving forward,” says Dr. Sella.

Dr. Sella’s recent research — published in the December 2024 issue of *Eye* — analyzed currently available AI-driven IOL calculation formulas, together with established formulas. Different formulas were compared using current guidelines and novel analysis tools.

AI-based formulas typically improve over time, especially when more high-quality data is available to fine-tune the algorithms. “It’s important to stop from time to time and assess the options we have today for IOL calculations,” says Dr. Sella. “This helps us understand which option currently provides the best accuracy overall and for specific types of eyes as well.”

To understand which formula showed the highest accuracy, researchers at Mayo Clinic, Moran Eye Center in Utah and Rabin Medical Center in Israel completed an in-depth analysis. This included 404 eyes of 404 patients who underwent uneventful cataract surgery. “We compared the refractive goal in those eyes to the actual outcome,” says Dr. Sella. “This was based on a set of different mathematical formulas that are widely available for surgeons to use.”

To perform this comparison, meticulous statistics and metrics were applied. “Our study shows that overall, AI-based formulas for IOL calculations perform very well,” says Dr. Sella. “Specifically, the Nallasamy formula — which integrates a machine learning algorithm — exhibited superior accuracy in predicting postoperative refraction in our group of analyzed eyes.”

Researchers also validated the use of a new readily available and user-friendly online tool for evaluating IOL power calculation formulas. “Eyetemis is available online at no cost and provides beautiful graphs to go along with your comparisons, which is valuable for research purposes or for any surgeon evaluating their own results,” says Dr. Sella.

“We utilized a robust database from the Moran Eye Center along with the expertise in IOL calculation research projects of my former research group in Israel,” says Dr. Sella. “With Mayo Clinic overseeing and guiding the process to support the study and publication, it’s an excellent example of the importance of collaboration across institutions.”

Work is currently underway on several other projects evaluating the accuracy of available and upcoming formulas in eyes with cataracts, which can be more challenging for IOL calculations.

“For example, we are looking into new formulas for calculations in short eyes where each measurement error translates into a more significant refractive error,” says Dr. Sella. “We’re also looking into eyes postrefractive surgery and eyes with corneal diseases like keratoconus where direct measurement of the posterior cornea may play an important role.”

Mayo Clinic’s Ophthalmology Parametric Universal Search (OPUS) database also provides a unique opportunity to detect less

represented eyes and improve outcomes. OPUS is a powerful AI-bioinformatic system that draws from 25 different databases, all of which are supported by Mayo Clinic’s Center for Digital Health.

“Our hope is to utilize all of our resources to provide patients with more predictable and accurate refractive results after surgery to meet their wishes and decrease glasses dependency,” says Dr. Sella.

FOR MORE INFORMATION

Reitblat O, et al. Accuracy assessment of artificial intelligence IOL calculation formulae: Utilizing the heteroscedastic statistics and the Eyetemis Analysis Tool. *Eye*. 2024;38:3578.

Advancing Patient Care Through Glaucoma Research

Glaucoma is the leading cause of irreversible blindness with 80 million patients affected worldwide. Multidisciplinary specialists at Mayo Clinic work together to generate new knowledge through cutting-edge research and to translate discoveries into therapies to advance patient care.

“Through advanced technologies and extensive resources, we’re committed to innovating research to better understand and treat glaucoma,” says Arthur J. Sit, M.D., M.S., an ophthalmologist and researcher at Mayo Clinic in Rochester, Minnesota. “The collective goal is to connect patients with optimal treatment options and improve overall outcomes.”

Therapies for glaucoma are primarily directed toward reducing intraocular pressure (IOP), which is the leading risk factor and only reliable therapeutic target. “However, most patients with elevated eye pressure do not get glaucoma, and up to half of people with glaucoma get the disease despite having typical eye pressure,” says Gavin W. Roddy, M.D., Ph.D., an ophthalmologist and researcher at Mayo Clinic. “Our team focuses on developing better treatment options for reducing pressure but also understanding the reasons for this paradox and identifying new options for treatment beyond lowering pressure.”

RECENT RESEARCH HIGHLIGHTS

Transgene expression of stanniocalcin-1 provides sustained intraocular pressure reduction by increasing outflow facility *PLOS One*, May 2022

Although topical therapeutics are typically first line treatments for patients with glaucoma, less than 50% of patients take drops as prescribed. Sustained release technologies that decrease IOP for extended periods of time are being examined for clinical use.

Stanniocalcin-1 was recently identified as an IOP-lowering agent. This research shows that a single injection into the anterior chamber of mice with an adeno-associated viral vector containing the transgene of stanniocalcin-1 results in diffuse and sustained expression of the protein and produces IOP reduction for up to six months.

As the treatment effect begins to wane, repeat injections have shown success in lowering IOP. Aqueous humor dynamic studies revealed an increase in outflow facility as the mechanism of action. This therapeutic approach has the potential to improve care and reduce the rates of vision loss in those affected by glaucoma.

Subconjunctival administration of an adeno-associated virus expressing stanniocalcin-1 provides sustained intraocular pressure reduction in mice *Ophthalmology Science*, July 2024

This research investigated subconjunctival administration of a single-stranded, adeno-associated virus, serotype 2, engineered to express stanniocalcin-1 with a FLAG tag (ssAAV2-STC-1-FLAG) as a novel sustained IOP-lowering agent with a reduced ocular surface side effect profile.

Subconjunctival delivery of ssAAV2-STC-1-FLAG significantly reduced IOP for 10 weeks postinjection in normotensive mice. Maximal IOP reduction was seen at week 3 postinjection. After the IOP-lowering effect had waned, a second injection restored the ocular hypotensive effect.

Subconjunctival delivery of the STC-1 transgene with a vector system may represent a novel treatment strategy for sustained IOP reduction and improved ocular tolerability. This also avoids the daily dosing requirements of currently available medications and the need for an injection inside the eye.

The effect of scleral buckle surgery on tonographic outflow facility, positional intraocular pressure, and ocular biomechanics
Ophthalmology Glaucoma, July 2023

This research investigated the in vivo effect of scleral buckle surgery on ocular biomechanics and aqueous humor dynamics. Participants included nine patients with unilateral 360-degree encircling scleral buckles without vitrectomy for rhegmatogenous retinal detachments, between three and 39 months postoperative.

Seated IOP was similar between buckled and nonbuckled eyes, whereas supine IOP was lower in buckled eyes compared with nonbuckled eyes. The percentage increase in IOP upon change in body position from seated to supine was greater in nonbuckled eyes. Ocular rigidity coefficient was lower in buckled as opposed to nonbuckled

eyes. Outflow facility was not significantly different in buckled and nonbuckled eyes.

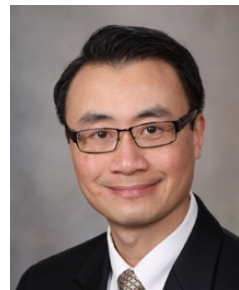
This research found that scleral buckling decreases ocular rigidity, but it does not affect outflow facility. This change in ocular biomechanics likely results in the attenuated IOP change from seated to supine position. Decreased ocular rigidity may also reduce IOP fluctuations and can potentially reduce the risk for glaucoma progression.

FOR MORE INFORMATION

Roddy GW, et al. Transgene expression of stanniocalcin-1 provides sustained intraocular pressure reduction by increasing outflow facility. *PLoS One*. 2022;17:e0269261.

Roddy GW, et al. Subconjunctival administration of an adeno-associated virus expressing stanniocalcin-1 provides sustained intraocular pressure reduction in mice. *Ophthalmology Science*. 2024;5:100590.

Lyons LJ, et al. The effect of scleral buckle surgery on tonographic outflow facility, positional intraocular pressure, and ocular biomechanics. *Ophthalmology Glaucoma*. 2024;7:1.



Arthur J. Sit, M.D., M.S.



Gavin W. Roddy, M.D., Ph.D.

Residents Highlight Camaraderie, Robust Educational Foundation

Mayo Clinic's Ophthalmology Residency aims to educate and inspire resident colleagues (Figure) within a stimulating environment to learn the science and art of ophthalmology. Each year, four new residents are welcomed into the program.

"I vividly remember the special moment when I found out that I matched with Mayo Clinic," says Rani Hassoun, M.D., a PGY-1 resident in ophthalmology. "Within minutes of receiving the news, our wonderful program director and several residents reached out to congratulate me and welcome me to the family. This early act of kindness and thoughtfulness quickly reminded me of why I had chosen to train at Mayo Clinic and rekindled my eagerness to begin training at a program that aligned with my goals."

Under the guidance of accessible, expert faculty, resident physicians manage a steady flow of patients with progressive clinical autonomy.

"Mayo Clinic's unique patient-centered and integrated practice offers an ideal environment for our residents' clinical, surgical and academic training in ophthalmology," says Andrea A. Tooley, M.D., director of the Ophthalmology Residency at Mayo Clinic in Rochester, Minnesota. "Residents develop meaningful patient relationships while serving patients with a wide range of medical and surgical ophthalmic conditions."

The Ophthalmology Residency draws trainees from diverse backgrounds, family status, and professional and personal interests. Learn more about some of our residents' experiences so far:



Figure. Resident using a surgical microscope for an ophthalmology surgical dissection (not shown) practice and simulation.



Andrea A. Tooley, M.D.



Rani Hassoun, M.D.

Hometown: Chicago, Illinois

Medical school: Northwestern University
Feinberg School of Medicine

HIGHLIGHTS

“Now that I’ve completed the first half of my intern year, I can confidently say that the training here has easily exceeded my expectations,” says Dr. Hassoun. “The sense of camaraderie and support among residents and faculty is what first stood out to me. There is truly a shared sense of commitment to Mayo Clinic’s tripartite mission — patient care, education and research.”

“Early on, it became evident that the consultants were heavily invested in our learning,” says Dr. Hassoun. “For example, whenever I’m on a nonophthalmology rotation, the consultants always make it a point to highlight the overlaps between ophthalmology and their particular specialty, such as rheumatology or dermatology.”

“As for my ophthalmology rotations, I have already completed rotations in oculoplastics and neuro-ophthalmology,” says Dr. Hassoun. “The teaching, mentorship and collegiality of the ophthalmology faculty have been outstanding, and I have built a robust foundation that will serve me well in the years to come.”

ADVICE FOR FUTURE RESIDENTS

“Always keep in mind the purpose behind your journey in medicine,” says Dr. Hassoun. “We are privileged to learn from and take care of patients — many of whom seek our help during vulnerable times, and they deserve our time and compassion.”

“Outside of the hospital,” says Dr. Hassoun, “continue engaging in your hobbies, enjoy meaningful time with friends, and keep in touch with your family!”

Sydney Roston, M.D.

Hometown: Mendota Heights, Minnesota

Medical school: University of Minnesota,
Twin Cities

HIGHLIGHTS

“Some highlights from intern year so far have included the hands-on learning, including suture clinics, wet labs and OR experiences,” says Dr. Roston. “I spent about a month in oculoplastics at the start of intern year, which was a great way to learn the logistics of the OR very early in our training.”

“I also spent a week with neuro-ophthalmology,” says Dr. Roston, “and right now I am doing a month of cornea. I’m looking forward to spending time in the resident clinic later this year.”

“So far, my year has been full of learning and new experiences,” says Dr. Roston. “I’ve completed rotations in gastroenterology, rheumatology, genetics, neurology, infectious disease, hematology and neuroradiology.”

“A fun element of our well-rounded training has included the opportunity to interact with the Caring Canines service dogs that come to visit,” says Dr. Roston. “Hopper, who belongs to one of last year’s chief residents, is an incredible part of the patient and staff-centered experience.”

ADVICE FOR FUTURE RESIDENTS

“Get to know as many of the people throughout other departments as you can,” says Dr. Roston. “I love that we spend so much time during this year with the more than 100 internal medicine co-interns who will be our future colleagues across all the internal medicine subspecialties.”

“I’d also recommend exploring all the hidden gems of Rochester and the surrounding area,” says Dr. Roston.



CONTACT US

Mayo Clinic welcomes inquiries and referrals, and a request to a specific physician is not required to refer a patient.

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Ophthalmology Update

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Cover Image

Human multicolored iris of the eye
animation concept. Credit: CG Alex

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