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Studies Support Scheimpflug Tomography's Efficacy in Predicting the Prognosis of FECD

There are no simple indicators of disease prognosis for Fuchs' endothelial corneal dystrophy (FECD). Although diagnosis of FECD is made by detecting the presence of guttae by slit-lamp examination, detecting the presence of subclinical corneal edema that frequently accompanies FECD is more challenging.

Studies conducted by Sanjay V. Patel, M.D., and fellow researchers with Ophthalmology at Mayo Clinic in Rochester, Minnesota, sought to determine whether Scheimpflug tomography pachymetry map and posterior elevation map patterns can predict the prognosis of FECD independent of central corneal thickness (CCT), and whether subjective interpretation of these maps was repeatable. The studies were published in *Ophthalmology* and *American Journal of Ophthalmology* in 2020.

FECD prognosis prediction

In a study of 96 eyes with a range of severity of FECD, cornea specialists graded corneas according to the area and confluence of guttae and the presence of clinically definite edema.

Masked and randomized Scheimpflug imaging pachymetry map and posterior elevation map patterns were assessed for loss of regular isopachs, displacement of the thinnest point of the cornea and the presence of posterior surface depression, which indicate the presence of subclinical edema (Figure).

The prognoses of eyes over a median five-year follow-up period were determined based on FECD progression or intervention by endothelial keratoplasty. Results included:

- In univariate analyses, loss of regular isopachs, displacement of the

thinnest point and focal posterior surface depression were strong risk factors for progression or intervention; CCT was not.

- In multivariate analyses, loss of regular isopachs and displacement of the thinnest point were independent and clinically important risk factors for progression and intervention. Posterior surface depression was highly correlated with loss of regular isopachs and was an independent risk factor if loss of regular isopachs was excluded from the model.
- The five-year cumulative risk of disease progression and intervention was 7%, 48% and 89% when none, one or two, and all three pachymetry map and posterior elevation map parameters were present.
- The four-year cumulative risk of disease progression and intervention after uncomplicated cataract surgery was 0%, 50% and 75% when none, one or two, and all three pachymetry map and posterior elevation map parameters were present.

"The presence of even one or two of the pachymetry map and posterior elevation map features increased the probability of FECD progression or intervention independent of CCT," says Dr. Patel. "Surgeons can be confident that FECD is unlikely to progress quickly after cataract surgery when these features are absent, preventing or delaying the need for endothelial keratoplasty."

Daily and hourly changes in corneal edema: Impact on image interpretation

The repeatability of subjective interpretation of Scheimpflug images was assessed in corneas with a range of severity of FECD in

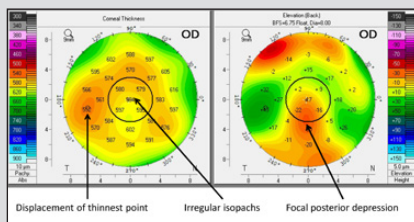


Figure. The presence of subclinical edema is indicated by loss of regular isopachs, displacement of the thinnest point of the cornea, and the presence of posterior surface depression in Scheimpflug imaging posterior elevation and pachymetry maps.



Sanjay V. Patel, M.D.

a randomized manner, to determine if variations in corneal hydration status with the time of day, or from day to day, would affect clinical decision-making. Results included:

- For images acquired within minutes on the same day, interpretations for individual tomographic features agreed for 88% or more of images and complete disagreement (disagreement for all three tomographic features in an image) occurred in 3% or less.
- For images acquired at a similar time on a different day, interpretations agreed for 77% or more of images and complete disagreement did not occur.
- For images acquired over the course of a morning, interpretations agreed for 81% or more of images and complete disagreement occurred in 6% or less.
- Intraobserver and interobserver agreement were both 93% or greater and complete disagreement did not occur.

“This repeatability study gives clinicians confidence that their interpretations of images will be consistent and that natural variations in the status of the cornea owing to diurnal or day-to-day fluctuations in hydration status are unlikely to result in erroneous clinical decision-making,” says Dr. Patel. “Clinicians should focus on the map patterns, as these usually remain consistent between repeat images even if absolute values of CCT vary.”

For more information

Patel SV, et al. Predicting the prognosis of Fuchs’ endothelial corneal dystrophy by using Scheimpflug tomography. *Ophthalmology*. 2020;127:315.

Patel SV, et al. Repeatability of Scheimpflug tomography for assessing Fuchs’ endothelial corneal dystrophy. *American Journal of Ophthalmology*. 2020;215:91.

Standardized Prescribing Guidelines Reduce Frequency and Quantity of Opioids Prescribed



Erick D. Bothun, M.D.

In response to the Minnesota Legislature’s 2018 call for opioid reform, Ophthalmology staff at Mayo Clinic in Rochester, Minnesota, launched a quality improvement study to determine the effect of implementing standardized opioid prescribing guidelines on prescription patterns for acute pain after ophthalmic surgery. “Despite the low overall number of opioid prescriptions written by ophthalmologists compared with other types of surgeons, any reduction in overprescribing is warranted,” says Sanjay V. Patel, M.D., Ophthalmology chair at the time of the study.

The department’s intent was to determine the impact of pain management education and opioid prescribing guidelines on prescribing patterns and to avoid opioid prescriptions of more than 80 oral morphine equivalent (OME) after any ophthalmic surgery.

Pain management education

The study team provided pain management education to all ophthalmic surgeons and trainees, including information about alternatives for pain control and pain medicine consultation. Surgeons were encouraged to supply no more than a seven-day course of opioids when deemed necessary; any further opioid requirements were to be managed by a pain medicine specialist. Target guidelines were posted in every operating room. Electronic flags were built into the electronic health record to alert prescribers if they were exceeding guidelines.

Guidelines standardization

The team used electronic health records to identify opioid prescriptions for acute postoperative pain for all opioid-naive patients 18 years of age or older who received ophthalmic surgery at Mayo Clinic in Rochester, Minnesota, in the study period (preimplementation period Oct. 1, 2017, through April 30, 2018 and postimplementation Oct. 1, 2018, through April 30, 2019). “The dates were chosen to prevent any bias that might have been introduced immediately before or after guidelines implementation,” says Dr. Patel.

For the purposes of the study, the team defined opioid-naive patients as those who did not have a history of long-term opioid use and had not received a prescription for opioids between 90 days and seven days before surgery.

The team compared postoperative opioid prescribing patterns — the frequency of opioid prescriptions, quantity of opioid prescribed and opioid prescription refill rates — before and after the June 2018 implementation of education and standardized guidelines. All prescriptions containing an opioid agonist, an opioid partial agonist or a combination opioid, with a Drug Enforcement Administration Schedule II or III, were included in the analysis.

“We sought input from all surgeons to reach consensus for the prescribing level appropriate for each ophthalmic procedure within their subspecialty, relative to levels with other subspecialties within the department and guidelines



George B. Bartley, M.D.

for general and orthopedic surgery as reference data,” says Erick D. Bothun, M.D., Ophthalmology Quality Chair at Mayo Clinic in Rochester, Minnesota, and study lead. “The department agreed to target a maximum prescription of 80 OME after ophthalmic surgery.”

Results from the three target prescribing categories included:

- Level 0 surgical procedures (0 OME recommended), including most anterior segment, eyelid and vitrectomy procedures, were the most commonly performed and least likely to be associated with opioid use — 2.3% before intervention and 1% after intervention. “Guidelines led to significant reductions in the number of Level 0 surgical procedures that received more than 40 OME,” says Dr. Bothun.
- The team noted similar improvement for Level 1 surgical procedures (40 or fewer OME recommended), including keratorefractive surgery, insertion of tube shunt or scleral buckle, adult strabismus, and globe trauma. “Although opioids were prescribed for 12.5% of Level 1 surgeries after intervention, none of the Level 1 surgical procedures was associated with prescriptions for more than 80 OME, compared with 4% before intervention,” says Dr. Bothun.
- Level 2 surgical procedures (80 or fewer OME recommended), including orbitotomy, enucleation or evisceration, and brachytherapy

plaque surgery, were assumed to result in the greatest risk of patients’ postoperative pain. All Level 2 cases met the recommended guidelines after intervention and none was prescribed more than 80 OME, compared with 5% before intervention.

The proportion of patients prescribed opioids decreased from 4.4% to 3.0%, and when opioids were prescribed, the OME also decreased from 93 to 42. The proportion of refill prescriptions for opioids did not differ, indicating similar levels of pain control before and after intervention. There were significant increases in the number of patients managed with less than 40 OME or without any opioids.

“The process of developing standardized opioid prescribing guidelines and discussing postsurgical pain management reduced the overprescribing of opioids without increasing refill rates,” says Dr. Bothun. “The data indicate that we still have opportunity for improvement, and even refinement of the prescribing guidelines, and continued discussion and education will be important.”

This study was published in *Ophthalmology* in 2020.

For more information

Starr MR, et al. Impact of standardized prescribing guidelines on postoperative opioid prescriptions after ophthalmic surgery. *Ophthalmology*. 2020;127:1454.

American Board of Ophthalmology Continuing Certification Eligibility

One of the components for Continuing Certification by the American Board of Ophthalmology (ABO) is participation in an Improvement in Medical Practice activity. George B. Bartley, M.D., Ophthalmology at Mayo Clinic in Rochester, Minnesota, and current American Board of Ophthalmology chief executive officer, notes: “This opioid project qualified for such credit for all Mayo Clinic ophthalmologists who participated. The ABO hopes that other departments or group practices will consider replicating this project, or investigating another clinical challenge relevant to the care of their patients.”

For more information, visit <https://abop.org/maintain-certification/improvement-in-medical-practice/>.

Fibrin Hydrogels Provide Safe, Degradable Scaffolds for Subretinal Implantation

Age-related macular degeneration is the leading cause of blindness in the developed world. The disease, which causes a loss of central, high-acuity vision, is thought to result from dysfunction of the retinal pigment epithelium (RPE).

The concept of treating age-related macular degeneration using RPE transplantation has been studied since the late 1980s, but few clinical trials were conducted due to lack of an abundant RPE cell source. Today, pluripotent stem cells offer that source; studies have demonstrated the cells’ reliable differentiation into RPE cells. “Since RPE cells are no longer a rate-limiting factor, the field has shifted focus toward development of a practical means of delivering RPE cells into the subretinal space,” says Alan D. Marmorstein, Ph.D., with Ophthalmology Research at Mayo Clinic in Rochester, Minnesota.

In an animal study published in *PLOS One* in 2020, Dr. Marmorstein and fellow researchers report the following about surgically implanted

fibrin scaffold (Figure, page 4) placed in the subretinal space:

- The scaffold consistently degraded within eight weeks without damage to the neurosensory retina or endogenous RPE.
- After the scaffold was degraded, the retina appeared to reattach to the underlying RPE.
- When the RPE was mechanically debrided, the implant was degraded within four weeks.

“To the best of our knowledge, this is the first report that demonstrates complete degradation of a scaffold within the subretinal space,” says Dr. Marmorstein.

Implantation device prototype development

To implant the fibrin scaffolds, the research team developed a novel insertion device with a rectangular housing tip geometrically optimized to house the implant. The outer dimensions of the tip were minimized to facilitate a small sclerotomy.



Alan D. Marmorstein, Ph.D.

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“To minimize hand-placement instability, we used a pneumatic-driven actuator that did not require finger manipulation, allowing compatibility with the viscous fluid injection module of common surgical vitrectomy systems, which can be triggered by a foot pedal,” says Dr. Marmorstein.

A rectangular, transparent housing tip allowed visualization of the implant, which permitted the surgeon to verify proper polarity of the implant and deployment without damage to the implant. The stainless steel hub was curved to parallel the inner surface of the eye.

The research team chose a surgical model compatible with current vitreoretinal surgical practice: It included a transvitreal, transretinal approach to gain access to the subretinal space through the creation of a retinal detachment and retinotomy following vitrectomy.

Successful placement of the fibrin implant into the area centralis was achieved in 16 animals. Three of these surgeries included mechanical debridement of the RPE. Twelve surgeries had fluid-air exchange, one received a silicone oil tamponade and two received approximately 20% sulfur hexafluoride (SF₆) gas tamponade. Results included:

- In cases with only fluid-air exchange, the air resorbed by day two or three postoperative.
- In cases with 20% SF₆ gas tamponade, the gas resorbed completely by day five postoperative. In cases with partial gas in the globe, imaging or a full indirect exam were not possible.
- In the case with the silicone oil tamponade, both optical coherence tomography (OCT) and fundus images were difficult to obtain, and indirect exam was the preferred method of examination.

When fibrin scaffolds were visualized with indirect ophthalmoscopy and OCT at one week, researchers observed a rectangular gap between the retina and underlying choroid-Bruch’s membrane-RPE tissue that was later confirmed by histology as the fibrin implant.

Of the 13 animals receiving fibrin scaffold implants in which RPE was not debrided, all showed signs of fibrin degradation over time. OCT images showed a raised plateau that completely resolved by week eight without damage to the retina or choroid-Bruch’s membrane-RPE tissue complex.

RPE debridement accelerates fibrin degradation

To test the hypothesis that removal of the native RPE may accelerate fibrin degradation, the research team mechanically debrided a region of the endogenous RPE in two animals. Over time, the fibrin implant degraded at a faster pace. Histology at four weeks confirmed no evidence of the implant.

“Our data demonstrate that fibrin is a degradable, safe material for subretinal transplantation. Fibrin implants degraded within eight weeks of implantation with no signs of damage to the neural retina or underlying choroid-Bruch’s membrane-RPE tissue complex, and debridement of the native RPE accelerated the degradation to four weeks post-implantation,” says Dr. Marmorstein.

For more information

Gandhi JK, et al. Fibrin hydrogels are safe, degradable scaffolds for subretinal implantation. *PLOS One*. 2020;15:e0227641.

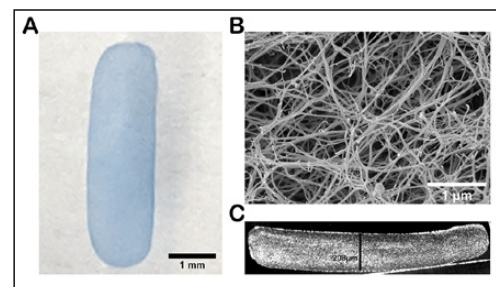


Figure. Fibrin hydrogel implant characterization. A. Brightfield image of a 1.5-by-5.0-mm fibrin implant colored with trypan blue. B. Scanning electron micrograph of the top surface of the fibrin implant shows characteristic cross-linking fibrils. C. Optical coherence tomography of the fibrin implant in cross-section demonstrates uniform fibril formation and thickness.

Education Opportunities

Visit <https://ce.mayo.edu/ophthalmology>, call 800-323-2688 or email cme@mayo.edu.

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