

Ophthalmology Update

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3D-Printed Models Aid Complex Orbital Reconstruction

When conditions such as cancer, trauma or complications from previous surgery affect the eyes, as well as surrounding facial structures, patients can benefit from a multidisciplinary approach. The Mayo Clinic Oculofacial Plastics Clinic (OFPC) in Rochester, Minnesota, streamlines evaluation and treatment for people with complex periorbital reconstructive needs.

Patients are evaluated by multiple specialists and receive any needed advanced testing, such as high-resolution CT scans for creation of 3D-printed models. Often, this can all be coordinated within a single day. A team of doctors reviews all clinical information and imaging and develops a treatment plan tailored to each patient's exact needs. After the multidisciplinary team develops a treatment plan, patients meet again with the team and discuss options for medical or surgical treatment.

"The OFPC is led by a plastic surgeon and an oculoplastic surgeon," says Lilly H. Wagner, M.D., an ophthalmologist and co-director of the Oculofacial Plastics Clinic at Mayo Clinic in Rochester, Minnesota. "If needed, other specialists are available for consultation, including dermatologists, head and neck surgeons, strabismus surgeons, and neurosurgeons."

"Any trauma with orbital involvement requires a comprehensive evaluation," says Basel A. Sharaf, M.D., D.D.S., a plastic and reconstructive surgeon and co-director of the Oculofacial Plastics Clinic (Figure). "Our collaborative effort with ophthalmology and oculoplastic surgery has been tremendously beneficial for our patients and for our teams."

In addition to the collaboration among specialties, the OFPC team works closely with specialized radiologists who create patient-specific 3D-printed models to support surgical planning. The integrated team helps solve complex surgical problems that arise during evaluation and treatment. This allows engineering, 3D printing and custom medical device manufacturing experts and surgical experts to work together.

"We started doing 3D printing about 17 years ago at Mayo Clinic, and it's expanded over that time frame to encompass every surgical subspecialty," says Jonathan M. Morris, M.D., medical director of the 3D Anatomic Modeling Unit at Mayo Clinic in Rochester, Minnesota. "The reason it started in-house is because we have subspecialty expertise in each part of the process. We had these complex problems, and we found that 3D printing aided in understanding them in a three-dimensional, life-size way that two-dimensional images could not."



Lilly H. Wagner, M.D.



Basel A. Sharaf, M.D., D.D.S.



Jonathan M. Morris, M.D.

Having the capability of in-house 3D printing reduces the amount of turnaround time needed. “Working in-house allows us to create things quickly — sometimes within 3 to 4 hours,” explains Dr. Morris. “The time it takes depends on the materials used and the complexity of the need, of course, but in general we can deliver something within a week or so. Working with a third-party company can take multiple weeks or months from start to finish.”

“It is incredibly helpful when physicians and surgeons are able to have the life-size 3D model in their hands,” says Dr. Wagner. “We can visualize where a tumor or injury is exactly located within the anatomy that’s usually covered up by soft tissue. Measurements can be made right on the model, and we can better understand what adjacent critical structures are nearby and what is the best approach to minimize the overall impact to the patient.”

The team also specializes in making custom 3D-printed patient-specific devices. “For example, if we have to cut a patient’s bone in a certain direction or trajectory,” explains Dr. Morris. “Then we take the patient’s imaging, create a 3D model of that patient’s skull or orbital socket or jaw or maxilla, and then do all of the cutting of the bones on a computer

program. This is referred to as virtual surgical planning.”

“Then we can actually ‘3D print’ a sterilizable jig, for lack of a better word, that screws on to the bone,” continues Dr. Morris. “And then, it guides a saw or a drill to a specific location in a very controlled manner, which allows us to do several things in the head and neck but also around the orbits.”

Aside from anatomic models for surgical planning, the 3D unit also creates bespoke items for patients such as prosthetics, hand braces, and custom devices or appliances that aren’t currently available in the marketplace. In addition to these applications, educational simulations can be created as new procedures become available.

“We also create training applications, cutting simulations and custom training modules,” says Dr. Morris. “For example, there was a new procedure in skull-based neurosurgery where we used 3D printing and silicone molding to create an entire training apparatus to be able to teach people how to put needles in and around the muscles that control the eye while the patient is essentially awake or asleep.”

With the combination of the multidisciplinary approach of the Oculofacial Plastics Clinic and the expertise of the 3D printing team, Mayo Clinic’s resources and capabilities are especially unique. “We are always looking for new or different ways to approach and solve problems, and having diverse perspectives is essential,” says Dr. Wagner. “When our teams combine as a whole, we’re able to solve many complex problems in innovative ways.”



Figure. Dr. Sharaf and Dr. Wagner are confirming the correct shape and fit of an orbital floor implant in the operating room, using an in-house 3D-printed model of the patient’s craniofacial skeleton.

Ophthalmology Conference 2024: Valuable Discussion and Scholarship

The Mayo Clinic Ophthalmology Update 2024 provided an opportunity for ophthalmologists, optometrists, physicians, residents, fellows and scientist-researcher Ph.D.s to connect and discuss comprehensive updates in ophthalmology and optometry for immediate clinical application.

The three-day live and livestream continuing medical education (CME) conference at JW Marriott Orlando Bonnet Creek, in Orlando, Florida, focused on a variety of topics across all

subspecialties, including light adjustable intraocular lens, orbital cellulitis, balancing thermal pulsation and intense pulsed light, and risk stratification and management of sebaceous carcinoma of the eyelid.

“The annual Mayo Clinic Ophthalmology Update is an opportunity for ophthalmology health professionals to come together to examine relevant, essential topics that will benefit their practice,” says Sophie J. Bakri, M.D., chair of Ophthalmology at Mayo Clinic

in Rochester, Minnesota. “It also fosters valuable discussion about new or updated treatment guidelines.”

Course directors included Dr. Bakri, Joanne F. Shen, M.D., former chair of Ophthalmology at Mayo Clinic in Phoenix/Scottsdale, Arizona, and Lilly H. Wagner, M.D., an ophthalmologist at Mayo Clinic in Rochester, Minnesota. The conference featured speakers from all three Mayo Clinic Ophthalmology sites and included case presentations, multiple Q&A panels, networking, and CME credits.

Transforming Healthcare and Research With AI-Driven Tools

Artificial intelligence (AI) has proved to be a useful tool that promises numerous benefits across healthcare and other fields. AI continues to evolve within healthcare with the goal of supporting patients and staff while improving outcomes, potentially lowering healthcare costs and benefiting population health.

Its success, however, is inherently tied to both the quality and quantity of the data used. A massive amount of high-quality data is necessary to train AI algorithms in order to get accurate results that will work with a broad range of patients.

Through its patient care and research initiatives, Mayo Clinic has been busy building one of the largest repositories of clinical data in the world. With more than 11 million patients with electronic records, Mayo Clinic currently has more than 250 algorithms under development.

One of the AI-driven tools developed within Mayo Clinic Ophthalmology is the Ophthalmology Parametric Universal Search, also known as OPUS. “OPUS is a powerful AI-bioinformatic system that allows us to search for specific patient cohorts in our medical records and build databases for AI training. Further, it strengthens our ability to do retrospective research and identify patients who might qualify for investigative prospective clinical trials,” says Raymond Iezzi Jr., M.D., an ophthalmologist and researcher at Mayo Clinic in Rochester, Minnesota.

“It also allows us to employ AI algorithms, analyze datasets and provide annotations,” continues Dr. Iezzi. “By curating annotated datasets, we can better find patterns of disease and assemble cohorts of patients for research.”

OPUS draws from 25 different databases, all of which are supported by Mayo

Clinic’s Center for Digital Health. “Mayo’s Center for Digital Health has been critical in supporting and maintaining the OPUS infrastructure and organizing the data,” says Dr. Iezzi.

The center is focused on transforming how Mayo Clinic delivers patient-centered care in the digital era. “The Center for Digital Health has the vision of bringing Mayo Clinic to a global community so that we can deliver Mayo Clinic care anywhere in a manner that is streamlined,” says Bradley C. Leibovich, M.D., medical director, Center for Digital Health.

Current projects at the Center for Digital Health include improved consumer experience for patients, expanding virtual care, and transforming healthcare delivery through data and analytics.

For Ophthalmology, using Mayo Clinic’s resources has been essential to continued development and utilization of OPUS. “OPUS was designed to let us automatically annotate large image sets,” says Dr. Iezzi. “For example, our group in Ophthalmology recently annotated 16 million retinal photos. OPUS is one of the most powerful, advanced AI informatic systems in ophthalmology today.”

The options for ways to use this technology are seemingly endless. “We’re also collaborating with other departments within Mayo Clinic to help determine how the analysis of images of the eye, known as oculosics, can help us better identify systemic diseases,” says Dr. Iezzi.

And the innovative options certainly don’t end within Mayo Clinic’s walls. “We are at the cusp of a major transition in computer and health information technology,” says Dr. Iezzi. “And it presents the opportunity to build a global network of collaborative organizations using research data and patient records.”

“Technology and data-driven innovation are making it possible for us to solve some of the most complex medical problems in novel ways,” says Dr. Iezzi. “It’s expanding our capabilities and transforming the way we cultivate knowledge — with the goal of ultimately enhancing outcomes for our patients.”



Raymond Iezzi Jr., M.D.



Bradley C. Leibovich, M.D.

Ophthalmic Pathology at Mayo Clinic



Diva R. Salomão, M.D.

Mayo Clinic has had a long-time tradition of expertise and excellence in the field of ophthalmic pathology.

Over the years, the ophthalmic pathology section at Mayo Clinic has grown to now include four subspecialized pathologists who review more than 800 cases every year.

“We provide primary diagnoses and consultation services on ophthalmic cases to patients at Mayo Clinic, other organizations in the U.S. and around the world. Our consultative practice strives to provide the highest quality diagnostic consultative service, balancing optimal patient care with a cost-conscious approach that supports the rapid turnaround time for diagnostic results,” says Diva R. Salomão, M.D., who joined Mayo Clinic in 1998 after completing her residency training at Mayo Clinic and fellowships in cytopathology and ophthalmic pathology at the University of Iowa.

Other members of Mayo Clinic’s Ophthalmic Pathology team include Joaquin J. Garcia, M.D., Jorge A. Trejo-Lopez, M.D., and Maria Adelita A. Vizcaino Villalobos, M.D.

Dr. Garcia is a pathologist with head and neck pathology expertise, whose research focuses on molecular pathogenesis of

lacrimal gland and salivary gland tumors. A professor of pathology, Dr. Garcia now serves as the chair of Anatomic Pathology.

Dr. Trejo-Lopez, a neuropathologist trained at the University of Florida, brings expertise in brain pathology, including neurodegenerative diseases, ocular pathology and autopsy pathology. He has several peer-reviewed published papers, including important collaborations with neuroradiology.

Dr. Vizcaino Villalobos, who pursued an ophthalmic pathology postdoctoral fellowship at Johns Hopkins, has published 29 peer-reviewed papers in such journals as *Human Pathology* and *Journal of Neuropathology & Experimental Neurology*.

Partnership with our colleagues in Ophthalmology and Laboratory Genetics and Genomics has resulted in the development of important ancillary testing and publications in the areas of diagnosis of vitreoretinal lymphoma and prognosis of uveal melanoma.

Better understanding of the molecular landscape of rare ocular disorders helps with patient management and better prediction of patients’ outcomes.

FOR MORE INFORMATION

For referring specimens from another institution, specimens should be sent to:

Ophthalmic Pathology
Mayo Clinic Laboratories
3050 Superior Dr. NW
Rochester, MN 55901-1195

Spotlight on Residents

Mayo Clinic Ophthalmology welcomes the latest PGY-1 resident class of 2028 and congratulates current graduating residents on their next endeavors.

Nirupama Devanathan, M.D.
Hometown: Fort Wayne, Indiana
Medical school: Indiana University School of Medicine

Rani Hassoun, M.D.
Hometown: Chicago, Illinois
Medical school: Northwestern University Feinberg School of Medicine

Sydney Roston, M.D.
Hometown: Mendota Heights, Minnesota
Medical school: University of Minnesota Twin Cities

Ia Ong C. Vang, M.D.
Hometown: Missoula, Montana
Medical school: Medical College of Wisconsin

Clara Castillejo Becerra, M.D., M.S., is joining the Cataract and Laser Institute of Southern Oregon as a comprehensive ophthalmologist.

Heidi M. Dahl, M.D., is joining private practice at Baptist Eye Surgeons in Knoxville, Tennessee.

Tyler M. Kaplan, M.D., is heading to the Bascom Palmer Eye Institute in Miami for a glaucoma fellowship.

Prashant Tailor, M.D., is going to the University of California, Los Angeles, for a vitreoretinal surgery fellowship.



CONTACT US

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

Phoenix/Scottsdale, Arizona
866-629-6362

Jacksonville, Florida
800-634-1417

Rochester, Minnesota
800-533-1564



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Clinical trials, CME, Grand Rounds, scientific videos and online referrals



EDUCATION OPPORTUNITIES

Visit ce.mayo.edu/ophthalmology
Call 800-323-2688
or email cme@mayo.edu

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Mayo Clinic Ophthalmology Update is written for physicians and should be relied upon for medical education purposes only. It does not provide a complete overview of the topics covered and should not replace the independent judgment of a physician about the appropriateness or risks of a procedure for a given patient.

Medical Editors

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Lilly H. Wagner, M.D.

Cover Image

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

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