The term "macular hole" was first used to describe a partial- or full-thickness hole in the foveal area. The area is susceptible to degeneration and hole formation because of its extreme thinness, avascularity, and lack of support by the neural and Müller cells.

The firm attachment of the vitreous to the basal lamina in the perifoveal area may be important in the pathogenesis of hole formation.1

The definitions of macular pseudohole (MPH) and lamellar macular hole (LMH) have been the subject of much discussion. A loss of foveal tissue is mandatory for a diagnosis of LMH2 (Figure 1).

Pathogenesis
The exact cause of macular hole re-

mains unknown. The first reported macular holes in the late 19th century were believed to result from trauma that caused cystoid changes in the macula.

Concurrent with the discovery around 1970 that the majority of macular holes were not associated with trauma, the predominant thought was that macular hole etiology was related solely to the presence of cystoid macular edema (CME) (Figure 1).3

Macular cysts are most often the result of chronic edema with coalescence of smaller cysts into a single or several larger cysts. Diabetic macular edema (DME) is a common condition associated with macular cysts.

In a study of 90 macular holes, trauma was involved in nine instances. The remaining cases were idiopathic, although ametropia and systemic hypertension were possible factors.4

Retinal pigment epithelial hypertrophy and hyperplasia may be seen in

MACULAR HOLE CONTINUED ON PAGE 3
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Macular hole

Continued from page 1

the area of both lamellar and complete macular holes. Outer LMHs may be seen with the breakdown of the blood ocular barrier at the retinal pigment epithelium (RPE) level. Retinal glial cells may grow onto the inner surface of the retina at the margin of a lamellar or complete macular hole.

Occasionally, a hole or attenuated area in an epiretinal membrane (ERM) in the macular area may simulate a macular hole (pseudohole).³

Diabetes mellitus was the most common condition associated with macular cysts. Residual CME was the most prevalent accompanying pathologic feature.

Wrinkling of the internal limiting membrane (ILM) and/or vitreous traction with or without an operculum was infrequently associated with macular hole.

Primary macular hole is commonly idiopathic.

Secondary macular hole occurs when the hole is caused by other pathologies not associated with VTM.

The most common non-traumatic entities include:
- CME
- Diabetic macular edema (DME)
- Blunt trauma
- High myopia

Solar retinopathy
Severe hypertensive retinopathy
In reality, the etiology of macular hole is probably multifactorial, and determining which is the primary event is less important than the recognition that VTM, foveal dehiscence, and other factors play a role.

Prior to the advent of optical coherence tomography (OCT) imaging, J. Donald Gass, MD, labeled these as vitreal interface maculopathies. Dr. Gass postulated that macular holes develop not from antero-posterior traction, as commonly thought, but rather from tangential traction that occurs when the posterior vitreous contracts.¹

Clinically, these entities have been described as surface wrinkling retinopathy, cellophane retinopathy, and the more modern ERM.

Epidemiology

Macular holes are most commonly unilateral, although there is an 5 to 15 percent change of macular hole developing in the fellow eye. About 75 percent of the time, they are associated with vitreomacular traction (VTM). They represent about 1.9 percent of visually impaired eyes ranging from 20/40 through 20/200.⁴

They are predominately found (2:1) in the female population with an average age of 6 to 80 years (mean 65).
Macular hole

Continued from page 3

Most macular holes are atraumatic or idiopathic in nature. They tend to enlarge over time and can contribute to epiretinal membrane formation.

Classification of macular hole

Dr. Gass classified macular hole in four stages:7

- **Stage 1A and 1B**: Localized perifoveal PVD, loss of umbo, cystic changes, sometimes foveal yellow spot
- **Stage 2**: Partial thickness; at this stage, treatment is generally peeling of the hyaloid with gas bubble
- **Stage 3**: Full thickness; operculum detached
- **Stage 4**: Completed PVD, hyaloid is no longer attached; a full thickness hole

Stage 1A, 1B

Gass divided the initial stage into Stage 1A, impending macular hole, and Stage 1B, an occult hole. Stage 1A has loss of the foveolar depression with a central yellow spot. Stage 1B appears as a yellow ring that is believed to represent centrifugal displacement of the foveolar retina and xanthophyll.

An “aborted” macular hole has the outer photoreceptor layer intact.

LMHs typically appear as round or irregular-shaped, well-circumscribed reddish lesions on biomicroscopy, but clinical detection at an early stage can be difficult. They usually resolve on their own.

Stage 2

**Partial macular hole**: Small central or arcuate perifoveal dehiscence. A minute hole forms near the center of the detached fovea. This is not an inevitable process. In 50 percent of cases, the vitreofoveal attachment spontaneously separates before a hole forms. This is followed by restoration of the normal foveal depression and improved visual acuity 20/50 to 20/80. Some 74 percent progress to Stage 3 (Figure 2).
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Macular hole
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Stage 3
Full-thickness hole with detached operculum: The most common presentation is yellow deposits at the RPE level. The full-thickness hole has a cuff of subretinal fluid >450 μm in size with a detached operculum. No PVD is present, and visual acuity is typically poor: 20/100 to 20/400. At this point, the hole stabilizes or, in the worst-case scenario, progresses slowly. (Figure 3)

Stage 4
The complete or “through-and-through hole: Completed PVD, hyaloid is no longer attached. At this point, a full thickness or loss of foveal tissue deep to the RPE with a loss of its pigment (xanthophylls) is the result. Usually associated with fully resolved VTM. (Figures 4-6)

The VTM theory of macular hole pathogenesis gained in popularity with the recognition that peripheral retinal breaks occur secondary to vitreoretinal traction on the posterior vitreous hyaloid and that strong adhesion exists between the vitreous and fovea. (Figure 7)

Pseudomacular hole
A pseudohole is when spontaneous partial detachment of the membrane has occurred inferiorly with a crescent-shaped scroll at the membrane edge. This makes it appear as if the fovea has a hole. OCT reveals an attached preretinal membrane that pulls the inner parts of the fovea toward the center, simulating a macular hole with cystoid changes in the central retina.

Myopia and macular hole
Malignant myopia and macular holes can be associated with high myopia and are referred to as myopic macular holes. High myopia is defined as a refractive error ≥−6.00 D of axial myopia with an axial length of >26 mm.8 The already-thin foveal tissue becomes even thinner with stretching of the retina, leading to development of the macular hole. (Figures 8A-C)

Traumatic macular hole
Formation of a traumatic macular hole is believed to be related to rapid changes at the vitreofoveal interface that occur during the traumatic event. In contrast to idiopathic macular holes that may occur over the course of weeks to months, the formation of traumatic macular holes happens more quickly.7 Other associated findings seen in traumatic macular holes—not present in idiopathic macular holes—include retinal pigment epithelium (RPE) mottling with damage to the RPE. Damage to the RPE appears to be directly related to the trauma. Despite the presence of RPE damage, visual recovery is still possible.5,10

Fortunately, the surgical closure rate (96 percent) and the visual improvement in traumatic macular holes are similar to that found with idiopathic macular hole closures.10 (Figures 9A and B)

Early macular hole imaging
From the 1970s through the early 1990s, color fundus photography and/or imaging utilizing the red-free filters built into fundus camera for angiography was the only modality available. Diagnostic B-scan echography still remains a poor modality of imaging for macular hole given its low resolution (about 150 μm) and the inability for sound to “see” the typical 5-μm hole.

▲ FIGURES 9A AND 9B.
The surgical closure rate (96 percent) and the visual improvement in traumatic macular holes are similar to that found with idiopathic macular hole closures.
Fluorescein angiography (FA) also remains a poor option for imaging due to its low resolution and lack of hemodynamic properties to macular hole. Typically, angiography might disclose hyperfluorescence in the early frames, with no leak in late frames (window defect).

However, FA is invasive and carries potential risks for adverse reaction, which is now thought to be predominantly anteroposterior (AP) in direction.

OCT can also be used to determine early macular hole closure following surgery. However, it may be difficult to obtain good quality images because of the presence of gas in the eye, particularly if the eye is already pseudophakic.

In vivo imaging of the FAF can be performed with commercially available adapted fundus cameras or confocal scanning laser ophthalmoscopes (cSLO). The cSLO needs specialized filters with an excitation wavelength of approximately 488 to 580 nm and a barrier filter at 500 to 715 nm, depending on the instrument used.

Role of OCT

OCT is able to noninvasively detect the presence of macular hole and changes in the surrounding retina. At an average of 3- to 5-μm resolution, minute changes can be detected.

The VTM theory of macular hole pathogenesis gained in popularity with the recognition that peripheral retinal breaks occur secondary to vitreoretinal traction and that strong adhesion exists between the vitreous and fovea.10

OCT has enhanced our understanding of the orientation of this

Role of fundus autofluorescence

One of the first studies published on the usefulness of FAF in patients with macular holes compared FAF with corresponding color fundus photographs, FA of the affected eye, and FAF images of the unaffected, contralateral eye.11

An increased signal at the sight of the hole by FAF was validated. In FAF, the signal derives predominantly from the lipofuscin in the RPE. In the normal eye, this signal is attenuated at the center of the macula by the presence of the luteal pigment, which has a higher concentration along the outer plexiform layer at the fovea.12

In the case of macular hole, and subsequent loss of luteal pigment overlying the defect, a marked FAF signal can be observed, delineating the hole.

While FAF has replaced FA in the evaluation of macular hole, it cannot replace OCT in all cases. OCT may still be needed when the differentiation between a lamellar hole (FAF will demonstrate increased foveal AF or FAF positive) and a pseudo-hole (FAF will show a normal pattern [FAF negative]).

Tips for imaging macular hole

Use the highest-resolution cube or line scan over the foveal area to capture the precise scan that best demonstrates evidence of a hole. Shorten the scan line to about 10° to maximize imaging only in the area necessary. Double-check the segmentation lines for accuracy in metrics.

(Figures 10A, B)

MACULAR HOLE CONTINUED ON PAGE 10

> FIGURES 10A AND 10B. When imaging macular holes, be sure to double check segmentation lines for accuracy.
Tips to become a better contact lens technician

By Phyllis L. Rakow, COMT, NCLEM, FCLSA(H)

Contact lens technicians wear many hats—including medical assistant, educator, interviewer, salesperson, arbitrator, and right hand to the doctor. As technicians learn, grow, and interact with patients, they are building practices.

As a technician with 42 years in the eyecare profession, I would like to share tips and skills that will enhance a technician’s value to the practice. These tips have helped doctors reduce chair time, see more patients, and develop their reputations as state-of-the-art contact lens practices.

Contact lens work-up
A good contact lens history is a critical skill. Every patient has a story, and technicians must convey these stories in the patient’s own language. If technicians interpret patients’ words and enter their histories on the chart in technical terms, something important may be lost in the translation.

A thorough contact lens history not only helps doctors select the right contact lens candidates, it helps them select the best lens modalities, materials, and care systems for each patient.

These questions will guide the doctor in the decision-making process:

- Many patients look younger than they appear. Technicians need to know the age of patients to find out if they are presbyopic. However, asking for a patient’s age may be uncomfortable. It is best to ask, “What is your date of birth?”
- Is the patient under treatment for any medical problems? Allergies, arthritis and other collagen diseases, diabetes, and thyroid problems are associated with dry eye disease. Antihistamines, decongestants, diuretics, Accutane, oral contraceptives, and MAO inhibitors also contribute to ocular dryness. Patients on immunosuppressing drugs may be more susceptible to infection.
  - Has the patient ever had a corneal abrasion or other injuries to either eye? Which eye, and how did it occur?
  - Has the patient ever had a serious eye infection or corneal ulcer?
  - Has the patient had eye surgery?
  - Does the patient have any other eye disease (e.g., keratoconus, corneal dystrophies, macular degeneration, cataracts, or glaucoma)?
  - How does the patient use his eyes at work and for leisure activities?
  - Is the patient involved in contact sports (soccer, football, basketball)?
  - What motivated the patient to want contact lenses? The motivating factors is the desire to see and be seen without glasses. Patients with frivolous reasons, such as, “My glasses tend to slip down my nose,” or “I’m always forgetting where I left my glasses,” are not motivated enough to assume the responsibilities of contact lens wear and care.
  - Is the patient currently wearing contact lenses, or has she tried them in the past?
  - If contact lenses are currently being worn, are there problems with vision, comfort, dryness, deposit buildup, or lens slippage?
- Is the patient currently wearing contact lenses part time or full time? How many hours on a typical day?
- If contact lenses were tried and discontinued, “Why did you stop wearing your contact lenses?”
- What is on the patient’s contact lens “wish list” (e.g., daily disposables, lenses for astigmatism, multifocals, lenses that are better for dry eyes)?

Visual acuity/corneal curvature
When testing visual acuity, it is important not only to record the near and distance acuity but to record how the patient reads the letters (20/20 easily vs. 20/20 with effort) or at near (J1 easily vs. J1 with effort). Many practices use automated refractor/kera tometry, making it impossible to evaluate the quality of the mires. For practices performing manual keratometry, any mire distortion or doubling should be recorded.

The gold standard for corneal curvature is topography, which will show the contour of the cornea over a much wider area and indicate irregularities. Contact lens technicians who master the techniques of keratometry and topography will increase their skills and save time for the doctor, thus increasing their value to the practice.

Contact lens emergencies
A good history of how the “emergency” occurred, followed by a check of visual acuity and inspection of the lenses for buildup, damage, or warpage is essen-
tial. Questions to ask the patient include:

- **Tell me how your eye feels?**
- **Is there pain, redness, discharge, or swelling?**
- **When did the symptoms start?**
- **Was the onset gradual or sudden?**
- **Did you try to treat them in any way?**
- **Did you go to your primary-care physician or the emergency room first?**
- **Did you sleep with your contact lenses last night, wear them in a smoky environment, or wear them longer than usual yesterday?**
- **Are your eyes unusually sensitive to light?**

**Routine follow-up**

Routine follow-up visits should be scheduled late in the day (except for patients wearing extended wear lenses) because redness, dryness, and other problems tend to show up when after lenses have been worn for several hours. Visual acuity should be checked, and keratometry or topography repeated if indicated.

Questions to ask include:

- **How many hours have you worn your contact lenses today?**
- **How many hours do you wear your contact lenses on a typical day?**
- **What lens care solutions are you using?** Patients may have switched from the recommended care solution to a solution that is incompatible with their contact lenses or to which they are sensitive.
- **Tell me what you do when you remove your contact lenses at the end of the day?** Patients may have switched solutions, may not be rubbing their lenses prior to disinfection, or may be “topping off” the lens case without rinsing their cases and refilling them with fresh solution each day.
- **Let me see your contact lens case.**

Cases harbor harmful micro-organisms. Besides nightly rinses, it is good practice to wipe the case weekly with a cotton ball dipped in alcohol and replace it every time a new bottle of disinfecting solution is started.

**Extended wear follow-up**

When extended-wear lenses are dispensed, it should be emphasized to the patient that “extended wear means extended care,” and they should be told to:

- Instill saline or rewetting drops in each eye upon awakening
- Ask themselves:
  - Do I look well?
  - Do I feel well?
  - Do I see well?
- Instill saline or rewetting drops at bedtime and as needed during the day.

Extended wear follow-up visits should be scheduled early in the day because most problems appear upon awakening. Patients should be asked whether they have experienced episodes of redness, pain, discharge, unusual light sensitivity, or blurred or foggy vision on awakening since their last visit.

**Turning telephone shoppers into patients**

Most telephone shoppers are looking for price, rather than quality of care. Many regard contact lenses as a commodity, rather than a medical device that requires careful fitting, thorough wear and care instruction, and regular follow-up visits.

When prospective patients inquire about price, the technician should inquire about previous lens wear, including problems with vision, comfort, and handling; satisfaction with current lenses; and whether the patient is interested in a different modality, such as lenses for astigmatism, multifocals, or daily disposables.

The fitting skills of the doctor and the quality of care should be emphasized, as well as the many choices of lenses and care systems that would provide the optimum fit and comfort. Fees should be discussed last, with an explanation to the patient that fees vary according to lens type, prescription, and lens-wearing history.

**Recycled/unsuccessful patients**

Some practices offer a reduced fitting fee for previous contact lens wearers. While these patients may save time by not needing instructions on lens application and removal, some patients will require added doctor time due to poorly fit lenses, irregular astigmatism, dry eye syndrome, giant-cell papillary conjunctivitis (GPC), a history of corneal infections and ulcers, or a corneal dystrophy.

Other patients may need more technician time in wear and care education because of a history of non-compliance. It is best to let the doctor determine the fitting fee after all information has been gathered.

Not all patients are successful candidates for contact lenses. They may not achieve the level of comfort or vision that they anticipated, or they may not master lens application and removal. Some patients may have severe corneal irregularities that make them impossible to fit.

A refund policy should be established based on material cost and time spent. Generally, fitting fees are non-refundable because a great deal of time has been spent with an unsuccessful patient.

If diagnostic disposable lenses were used, no material costs are involved. However, if several pairs of custom toric or gas permeable lenses have been ordered and tried, there are mailing costs and restocking fees to factor...
Macular hole
Continued from page 7

If your OCT has an en face feature, add this to maximize imaging of the fluid cuff. VMT often results in intraretinal splitting along a plane of anatomical weakness at Henle’s Fiber Layer and the outer plexiform layer, resulting in a characteristic en face appearance. The ability to visualize and quantify the extent of intraretinal splitting with a single en face image provides a useful tool for monitoring disease progression.

Future macular hole imaging
With the advent of optical coherence tomography angiography (OCTA), this new modality may hold the key to the best of both imaging worlds—angiography and OCT.

References

CL tech
Continued from page 9 into the refund.

However, think about future patient referrals and remember that a rigid refund policy may hurt the practice more than a small refund to an unsuccessful patient. It helps to maintain patient goodwill by applying part of the retained fitting fee to a future contact lens trial.

Requests for prescription release
According to Public Law 108-164, signed into law in December 2003, contact lens fitters must provide patients with a copy of their contact lens prescriptions. The patient should receive the copy when the fitting is complete, even if patient didn’t ask for it, so he is able to obtain contact lenses from his supplier of choice.

“Fitting” is described as “the process that begins after the initial eye exam and ends when a successful fit has been achieved.” In the case of re- newal prescriptions, the fitting is achieved when the prescriber determines there is no change in prescription.

If a third-party supplier requests a prescription, the prescriber must confirm its accuracy by direct communication with the seller—or inform the seller that the prescription is not correct and provide the accurate information. A reason must be given for an invalid prescription (e.g., “expired”).

Non-confirmation is confirmation! If the prescription is not confirmed within eight business hours, the supplier is legally permitted to fill the prescription.

It is important for the contact lens technician to ensure that every request from a third-party contact lens supplier is confirmed in a timely manner. Non-confirmation of an expired or invalid prescription could expose the technician and/or the fitter to malpractice.

Prescriptions are valid for a minimum of one year, except in cases in which the prescriber thinks that the ocular health of the patient is at stake such as keratoconus, giant-cell papillary conjunctivitis (GPC), recurrent infections or ulcers, and therapeutic lenses or bandage lenses.

Short expiration dates must be supported by accurate records of medical necessity. The prescriber must include the original prescription and expiration dates and can limit the quantity of even ordinary lenses to be purchased if the expiration date is near.

The scope of practice for contact lens technicians is extensive. On-the-job training, journals, interaction with contact lens and solution sales reps, and conferences (e.g., American Optometric Association [AOA], Southeastern Council of Optometrists [SECO], American Academy of Ophthalmology, and Vision Expo East and West) offer courses to help technicians expand their knowledge base and develop skills that will enhance their value, increase their professionalism, and turn their jobs into careers.
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