

REVIEW[®] OF OPTOMETRY

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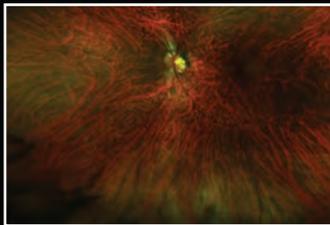
DIAGNOSTIC SKILLS AND TECHNIQUES

OCT-A

This new, noninvasive technology is giving a more detailed view of the retinal vasculature than ever.

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ZEISS AngioPlex



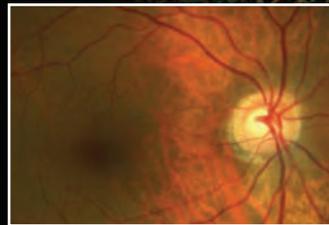
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Condensing Lenses: Sharpen Your Skills in Choosing and Using

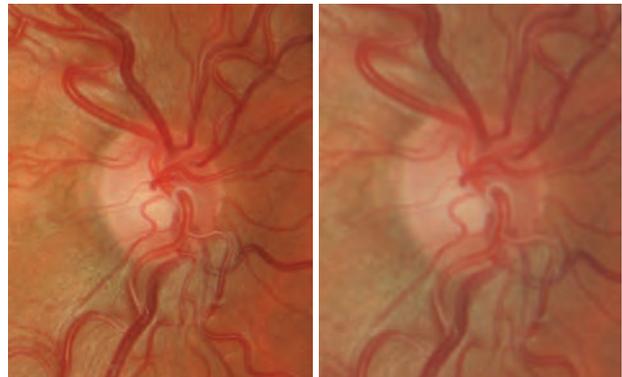
These devices remain vital to everyday practice. Are you making the most of them?

By Philip E. Walling, OD, Joseph Pole, PhD, Paul Karpecki, OD,
Nick Colatrella, OD, and Jeffrey Varanelli, OD

We are very fortunate that in our profession, unlike most other medical fields, it is possible to noninvasively examine the organ of interest. This “window” to the eye provides so much information about the patient’s general well being. As optometrists, we have an obligation to detect and manage a multitude of eye and related health problems, and our choice of equipment to fulfill this duty is crucial. Although exciting high-tech devices, such as OCT, have revolutionized the way we detect and monitor eye disease, the newer equipment has not invalidated the humble handheld lens. Condensing lenses have the benefit of being readily available, relatively low cost and highly portable. This article will discuss the different types of diagnostic and therapeutic lenses, why optometrists may find these techniques helpful and what devices have become available more recently.

There are myriad condensing lenses available today for use with the slit lamp or the binocular indirect ophthalmoscope (BIO). In essence, the lenses are broken down into high magnification lenses, used to visualize great detail, and wide-angle lenses, used to cover a large area in a single view. Some are best used with dilated pupils and others through small pupils. We will break down each type of lens and offer some recommendations based on our experience.

The most commonly used lenses are indirect, also known as “aspheric” and “condensing” lenses, which are classically used at a slit lamp—for example, 78D or



Increased magnification (right) results in a “hazier” view.

90D lenses—or with a head mounted binocular indirect ophthalmoscope (e.g., 20D or 28D lenses). These are the traditional optics familiar to all eye care practitioners. They work very well and are available in a range of powers and designs.

Indirect Ophthalmoscopy Lenses

Slit lamp indirect ophthalmoscopy has become the standard diagnostic procedure for comprehensive eye examination. Volk Optical introduced the 60D lens in the early 1980s and, in subsequent years, extended the range of lenses for the slit lamp by adding additional powers. Over time, indirect ophthalmoscopy has come to replace the previously widespread use of direct ophthalmoscopy, and with good reason. Advantages include a larger field

of view, a comfortable working distance between practitioner and patient, and most importantly a stereoscopic view, which enhances depth perception and helps provide a more comprehensive examination.

These lenses form a real, inverted image of the retina in between the lens and the practitioner. The technique is not always easy to master, but the benefits are notable once the user becomes proficient. Since the image is inverted and reversed, making a sketch of the retina on paper can be readily achieved by turning the page upside down and drawing what is seen, allowing for a simple conversion when the page is properly reoriented. Another tip for successful examination is to view the periphery sequentially and leave the macula until last, as taking patient comfort into account is likely to improve compliance.

Since the power of the optic dictates the magnification and field of view (see “*Crunching the Numbers: Magnification and Field of View*,” p. 60), different lenses have distinct characteristics, which allow the doctor to select the best lens per their preference and the specific task to be addressed. Let’s consider their value for a variety of tasks.

Head-mounted BIO. When using the BIO, the type of condensing lens is as important as turning the light on. The advances in technology over the last few years have enabled a much more efficient and detailed examination of the retina, macula and optic nerve. Each has their advantages and disadvantages.

The main workhorse lens for use with the BIO is the 20D lens. This relatively low-powered lens (2.2D, 20D, Volk Optical; 20D Ocular Instruments; Diamond 20D Katena) is a compromise between magnification and field of view. Seeing subtle hemorrhages in the posterior pole with a red-free filter and analyzing peripheral retinal anomalies with scleral depression are its best qualities. It works best with a fully dilated pupil.

Advances in design have minimized reflections, allowing unobstructed views. Ocular Instruments has an attachment for its Maxfield 20D lens called the Saxena Retinal Grid 520, which fits onto the front side of the lens. It has a grid pattern of monofilament lines spaced at 5.20mm, which helps in estimating the size of retinal lesions, choroidal nevi and other anomalies in need of documentation by comparing the grid size with the optic nerve head. If a camera is not available, estimating the size with the grid provides a reliable measurement, which can be referenced at subsequent visits to rule out progression. Volk has developed a series of lenses with low dispersion glass and anti-reflective coating to further minimize reflections. The

Table 1. Indirect Lenses and Their Typical Use

Power	Purpose	Application
90D	View the posterior pole using a slit lamp	Good general purpose lens. Alternative to 78D if the practitioner elects to use just one lens.
78D	View the posterior pole using a slit lamp	Good all-around lens. Ideal option if the practitioner uses a single lens.
60D	View the posterior pole using a slit lamp	Ideal for optic nerve head examination as lens offers higher magnification near 1x.
28D	View the retina including periphery using a head-mounted BIO	Lower magnification than 20D. Ideal for pediatric examination, when scleral indentation is required and for patients with nystagmus. Useful when slit lamp examination is not possible.
20D	View the retina including periphery using a head-mounted BIO	Higher magnification than 28D. Ideal for pediatric examination, when scleral indentation is required and for patients with nystagmus. Useful when slit lamp examination is not possible.

Digital ClearMag is designed to replace a 14/15D lens because of its increased magnification and the Digital ClearField is designed to replace a 20D/2.2 lens.

The lower dioptric power lenses (MaculaPlus 5.5x and 15D, Volk Optical; 16D, Ocular Instruments), which have greater magnification, are good for evaluating the posterior pole including a clear, stereoscopic view of the macula, optic nerve and nerve fiber layer. They also come in handy when a patient is unable to sit behind the slit lamp and a more detailed view of the optic nerve is needed—for instance, to estimate rim tissue in glaucoma or the macula to rule out macular edema. The only disadvantage to these lenses is the long working distance from the cornea. Long fingers are needed to steady the lenses; however, practitioners can use two hands and place the ulnar side of the palm of one hand on the patient’s forehead, while the other hand rests on top of it.

The medium dioptric powered lenses (28D, 30D Volk Optical, 30D Ocular Instruments; Diamond 28D, Katena) are ideal for patients with small pupils or a constricted, opaque capsulorhexis opening of the anterior capsule following cataract surgery. They provide a larger field of view while sacrificing some magnification. You have to be even more discriminating when examining the fundus because of the lack of magnification. Ocular Instruments also has an attachment for its Maxfield 28D

Diagnostic Lenses

Crunching the Numbers: Magnification and Field of View

Indirect ophthalmoscopy is performed when the examiner views the image of a patient's fundus through a condensing lens. Handheld lenses typically range in power from +14.00D to +40.00D, while condensing lenses included in a slit lamp may have a power as high as +120.00D. The resulting magnification is:

$$M = -\frac{P}{C} \times M_E$$

where P is the total dioptric power of the patient's eye and C is the power of the condensing lens.

M_E represents the amount of additional angular magnification needed for the examiner to clearly view the image produced by the condensing lens. M_E is usually computed or quoted in reference to a standard viewing distance of 25cm (4D). The method of computing M_E depends on how the examiner views the lens image. If the examiner performs handheld indirect ophthalmoscopy and has a sufficient amount of accommodation to view this image, then:

$$M_E = \frac{A}{4}$$

where A is the amount the examiner accommodates in diopters. If the examiner is presbyopic, A represents the add power used by the examiner for near viewing.

Consider a presbyopic examiner performing handheld BIO on an emmetropic patient. The examiner wears a +23.50D add. The refracting components of this patient's eye (cornea and crystalline lens) may be modeled by a +60.00D thin lens. When the examiner holds a +16.00D condensing lens in front of the eye and views the image through the add, the magnification is:

$$M = -\frac{+60.00 \text{ D}}{+16.00 \text{ D}} \times \frac{+2.5 \text{ D}}{4} = -2.34x$$

It should be noted that as the condensing lens power increases, the amount of magnification decreases. While the above formula assumes that the patient is emmetropic, the presence of refractive error has little to no effect on the size of the lens image.

If indirect ophthalmoscopy is performed with a slit lamp, then M_E simply represents the amount of auxiliary magnification provided by the device. For example, consider the examiner viewing the emmetropic patient described above. She replaces the handheld condensing lens with a +90.00D lens in a slit lamp set at 10x magnification. The magnification in this scenario becomes:

$$M = -\frac{+60.00 \text{ D}}{+90.00 \text{ D}} \times 10 = -6.67x$$

If the magnification of an optical system increases, the maximum possible size of the field of view (FOV) will decrease. For indirect ophthalmoscopy, the field of view is determined by the diameter of the condensing lens, its location with respect to the patient's eye, and the power of the patient's eye (P):

$$FOV = \frac{\text{condensing lens diameter}}{\text{eye to condensing lens distance}} \times \frac{1}{P}$$

To achieve the largest possible field of view, the distance from the lens to the eye must be approximately equal to the focal length of the lens, although the position of the examiner will make this distance slightly larger.

Consider again the examiner performing handheld indirect ophthalmoscopy on an emmetropic patient with a +60.00D eye. The +16.00D condensing lens has a diameter of 50mm. The examiner holds this lens 7.26cm in front of the patient's eye. The resulting field of view is:

$$FOV = \frac{5.0 \text{ cm}}{7.2 \text{ cm}} \times \frac{1}{60.00 \text{ D}} = 0.012 \text{ m} = 12\text{mm}$$

lens called the Saxena Retinal Grid 428, for help in estimating the size of lesion and nevi.

Very high-powered 40D lenses work well for retinal screenings, especially in patient populations where seeing into the eye is a challenge in itself. A large swath of retina can be seen at one time to rule out any obvious disease.

At the slit lamp. Typically, the 78D with 0.77x magnification is a versatile all-around lens; if practitioners are to own just one lens, this may well be the best choice. The 90D (0.64x) is an alternative option, as it too is an appropriate general-purpose lens. The 60D lens is especially suitable for disc imaging since it offers higher magnification of approximately 1x; the unit magnification also means that no conversion is required when measuring disc size. The 20D and 28D lenses are ideal when more magnification is required, or when a longer working distance is desired. These lenses are preferable when patients can't work with the slit lamp, for children where a panoramic view is valuable and viewing time is limited, and for situations where imaging is challenging such as nystagmus or when scleral indentation is required (Table 1).

All indirect lenses have the advantage of creating an image is relatively independent of the power of the eye and so this technique is preferable for patients with high a refractive error. Significant astigmatism of more than five diopters, particularly if it is oblique, will noticeably impact the image. The only way to improve the quality of imaging further is to use a diagnostic lens that contacts the eye, as this will neutralize the irregularities in the cornea.

Selection factors. When choosing a lens, some of the key performance aspects to keep in mind include image quality, amount of light required, ease of imaging through the limiting pupil and the ergonomics of clinical use. Lens ergonomics specifically focus on the way it handles, the ease of control, the lens weight and general handling comfort. Much of this depends upon individual preference and previous experience. Traditionally indirect lenses have been made from glass and have a lens holder with knurling. This tried-

and-true design is a favorite with many practitioners.

Some newer lenses have a different appearance, with a silicone grip (designed to improve lens control); these are more lightweight due to the materials used. The PMMA lens is lighter than a traditional glass lens and it is protected from scratches by a hard coating made of evaporated diamond.

Lenses for small pupils. New optical designs claim to improve imaging through small pupils, such as for patients whose pupils do not dilate well. Lenses from Katena use a steeper front surface to move the ray bundle forward into the pupil plane. This design is meant to be more efficient than designs that position the ray bundle further back in the eye, closer to the nodal point.

In practice, the efficiency in the illumination pathway means that lower light levels can be used during the examination. This may improve patient comfort and cooperation, particularly with children. Additionally, for those patients whose pupils do not dilate well—for example, individuals with diabetes or patients taking alpha-blockers such as tamsulosin—imaging the retina or at least the macula is usually still possible.

Fundus Biomicroscopy Lenses

These devices are essential in the evaluation of the optic nerve in glaucoma, maculopathy and peripheral retinal disease. After performing BIO and finding an anomaly, using condensing lenses designed for the slit-lamp allows for an “up-close” look at the condition.

The optic nerve is best examined using a low-power biomicroscopy lens (e.g., 60D, Super 66 (66D), Volk Optical; 60D Ocular Instruments; Diamond 60D, Katena). Such a lens allows for greater magnification without having to use the high magnification of the biomicroscope, which results in a hazy view as the magnification of the slit lamp approaches the diffraction limits of light. Having a crisp image gives a detailed, clear view of the neuroretinal rim tissue that is vital in diagnosing and managing glaucoma.

The macula is also visualized well with the low-powered lenses. When macular changes are suspected, using a lower-power lens allows a detailed view of the inner and outer retina, especially the retinal pigment epithelium (RPE). Visualizing the granularity of the RPE is an acquired skill but a necessary one. Subtle RPE changes can be one of the first signs of macular disease.

Peripheral fundus lesions are seen well with a high-powered biomicroscopy lens (e.g., 90D, SuperField, SuperVitreofundus, Volk Optical; 90D, panfundus, Ocular Instruments; Diamond 90D, Katena). They allow the practitioner to see in great detail anomalies



The medium dioptic powered lenses provide a larger field of view while sacrificing some degree of magnification.

that may still be questionable after performing indirect ophthalmoscopy. The views possible from the BIO, scleral depression and the peripheral fundus lens gives the practitioner the information needed to make a specific diagnosis.

Diagnostic Contact Lenses

While binocular indirect lenses offer significant benefits, another tremendously valuable way of imaging the retina is to use a contact diagnostic lens. Lenses such as Volk's SuperQuad 160, Ocular Instruments Mainster PRP 165 or a Katena disposable Retina 180 provide access to even the most peripheral retina—a good view out to the ora serrata can be achieved. These lenses are surprisingly easy to use, assisted by the stability of the lens on the eye and more control over the eye and lids.



The 20D lens is a good compromise between magnification and field of view.

Table 2. Condensing Lenses Comparison Chart

Note: different lens manufacturers use different eye models to calculate magnification and field of view, hence the specifications are not directly comparable.

BINOCULAR INDIRECT OPHTHALMOSCOPY CONDENSING LENSES					
Manufacturer	Lens	Field of View	Image Magnification	Working Distance	Best Use
Katena	Diamond 20D	53	3.0x	48mm	General fundus exam
Katena	Diamond 28D	53	2.1x	35mm	General fundus exam
Ocular Instruments	MaxField 20D	50	2.97x	47mm	General fundus exam
Ocular Instruments	MaxField 30D	63	1.97x	26mm	Small pupil/large fundus area
Ocular Instruments	MaxField 40D	82	1.49x	14mm	Small pupil/large fundus area, pediatric exams
SVT	20D	46/60	3.13x	50mm	General fundus exam
SVT	30D	58/75	2.15x	30mm	Small pupil/large fundus area
Volk	Macula Plus 5.5	36/43	5.50x	80mm	High detailed view of disc, macula and post pole
Volk	15D	36/47	4.11x	72mm	High detailed view of disc, macula and post pole
Volk	Digital ClearMag	38/49	3.89x	60mm	High detailed view of disc, macula and post pole
Volk	20D	46/60	3.13x	50mm	General panretinal fundus exam
Volk	Digital ClearField	55/72	2.79x	37mm	General panretinal fundus exam
Volk	Panretinal 2.2	57/73	2.68x	40mm	General panretinal fundus exam
Volk	30D	58/75	2.15x	30mm	Small pupil/large fundus area
Volk	40D	69/90	1.67x	20mm	Small pupil/large fundus area; good in pediatric exams
SLIT LAMP CONDENSING LENSES					
Manufacturer	Lens	Field of View	Image Magnification	Working Distance	Best Use
Katena	Diamond 60D	68	0.96x	14mm	ONH and macula; posterior pole
Katena	Diamond 78D	80	0.77x	10mm	General fundus exam. Small pupil/large fundus area
Katena	Diamond 90D	75	0.64x	8mm	Panretinal fundus exam. Small pupil/large fundus area
Ocular Instruments	MaxField 60D	85	1.00x	10mm	ONH and macula; posterior pole
Ocular Instruments	MaxField High Mag 78D	88	0.98x	10mm	General posterior pole exam
Ocular Instruments	MaxField Standard 90D	94	0.75x	5mm	Panretinal fundus exam
SVT	60D	68/131	1.15x	10 to 13mm	Posterior pole exam
SVT	115D	95/155	0.76x	7mm	Small pupil/large fundus area
Volk	Digital High Mag	57/70	1.30x	13mm	Posterior pole, macula
Volk	60D	68/81	1.15x	13mm	ONH and macula; posterior pole
Volk	Digital 1.0x Imaging	60/72	1.0x	12mm	General posterior pole exam; photography
Volk	Super 66	80/96	1.0x	11mm	Posterior pole, macula
Volk	78D	81/97	0.93x	8mm	General posterior pole exam
Volk	Super Field	95/116	0.76x	7mm	Panretinal fundus exam
Volk	90D	74/89	0.76x	7mm	Panretinal fundus exam
Volk	Digital Wide Field	103/124	0.72x	4 to 5mm	Panretinal fundus exam

While it is somewhat inconvenient to anesthetize the eye and use contact fluid, the imaging quality and access to ocular structures make the effort worthwhile.

For the anterior segment, contact lenses are required to view the anterior chamber since the mirrors within the lens are required to overcome the cornea's total

internal reflection.

Gonioscopy. This technique is the key to accurate and timely diagnosis of glaucoma and is an important skill that all optometrists should hone. For example, a 4-mirror lens allows imaging of all four quadrants of the anterior chamber angle without excessive rotation of the lens since the illumination of the slit lamp can

be efficiently scanned across each mirror. This lens has two additional advantages: it can image the central 30° of the posterior pole and full lens visualization can be achieved without using contact fluid.

An alternative to the customary 4-mirror lens is a 3-mirror lens. This one will access four different zones within the eye. Consequently, it is considered an “all-purpose lens,” as this device used on its own allows a comprehensive eye exam. It does take time to master the rotation of the mirrors along with movement of the slit lamp beam and the subsequent interpretation, but once achieved, this is an ideal lens for a thorough examination. This is evidenced by the 3-mirror lens remaining in routine eye care with minimal changes to the optics for the last 50 years.

Diagnostic Lenses for SLT. With an increasing number of states expanding the scope of practice to allow optometrists to perform certain laser procedures, it is worth reviewing the lenses associated with argon and selective laser trabeculoplasty (SLT), Nd:YAG capsulotomy and Nd:YAG laser peripheral iridotomy. Again, each of the three main manufacturers offer suitable lenses for SLT; Ocular Instrument’s Latina, Volk’s single mirror and Katena’s single mirror lenses are all examples of this utility. The Katena single mirror lens is available both with and without a handle. For capsulotomy, the best known lenses are Volk’s reusable capsulotomy or their new single use lens, or Katena’s single-use capsulotomy.



Use low dioptic power lenses for a clear, stereoscopic view of the macula, optic nerve and nerve fiber layer.



The Saxena Retinal Grid can help in estimating the size of lesions and nevi.

Photo: Ocular Instruments

A broad selection of lenses is available to meet every clinical need and budget. These diagnostic and therapeutic lenses have stood the test of time, and the reusable style having been widely used over the last five decades. Lenses have recently undergone their own evolution due to modern manufacturing. This makes disposable lenses feasible and it is likely that they will become increasingly popular. Optometrists now have a wider range of lenses to choose from to address the various needs of their practices. ■

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Infection Control for Contact Lenses

For lenses that touch the eye, there appears to be a trend towards disposable products. Both Volk and Katena offer single-use lenses in individual sterile pouches. They are popular in hospitals because of the time, cost and logistics of disinfecting traditional reusable lenses. The convenience of an immediately available sterile lens in a busy environment is very often welcome.

With infection control always on the agenda in clinical environments, disposable medical devices have their place. Office-based practices may choose to use disposable lenses on “challenging” patients—for example, those with known hepatitis, HIV or a history of drug use. Practices may also benefit from the efficiencies in staff time and removal of disinfection chemicals. Single-use lenses are also a cost-effective way of trying a new type of lens without investing hundreds of dollars.



Photo: Katena

Katena’s 4-mirror single-use gonio lens.

Over 20 years' time, technology
has changed everything—
except your lenses...

Until now.

Diamond bi-aspheric lenses

Exceptional optics

- Anti-reflection coatings
- Low distortion & high resolution
- Superior small pupil performance

Ergonomic, durable design

- Lightweight construction
- Silicone grip
- Scratch-resistant diamond hard coating



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