**Introduction**

Surgical microscopes are a cornerstone for ophthalmic practices. Advanced microscopes can provide a depth of focus and red reflex stability that enhances visualization, and impacts surgical efficacy, patient satisfaction and outcomes as a result. Surgeons should consider the advantages and disadvantages of incorporating an upgraded microscope system into their practice.

Ocular Surgery News, through the sponsorship of Alcon Laboratories, Inc., assembled a panel of experts to review the anatomy of advanced technology ophthalmic microscopes and provide perspectives on how specific aspects of microscope systems affect surgical performance.

I thank the faculty for their participation, and Alcon Laboratories, Inc., for sponsoring this supplement. For more educational activities on this topic, visit Healio.com/Ophthalmology/Education-Lab.

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Advancements in microscope technology improve cataract surgery

Robert J. Cionni, MD

Advanced surgical microscopes open the door to a view of the eye that surgeons have never been able to achieve before, along with the opportunity to implement the use of additional advanced technologies for other aspects of surgery. Such high-quality visualization creates the potential for a seamless and safe experience for both the surgeon and the patient.

Factors for a quality microscope

The three most important factors to consider when choosing a high-quality microscope are the ability to provide a stable red reflex, substantial depth of focus and the ability to display crisp visual details. Most microscopes today utilize a focused light to create crisp detail when the pupil is well centered. However, if the eye is not in the center of the field of view or is tilted, the red reflex is lost and creates a shadow. Consequently, the surgeon cannot see the area under the shadow well, and that can increase the risk for complications. Poor visualization also forces the surgeon to slow down and move the microscope left to right more often to accommodate for that loss of the red reflex when the surgeon does not have the microscope in the center of his or her field of view. The better the red reflex stability, even when the eye is not in the center of the field, the more likely it is that the surgeon will not have to constantly move the microscope, and the more likely he or she will be able to view all details of surgery at once. The LuxOR Ophthalmic Microscope (Alcon Laboratories, Inc.) provides a red reflex that is six times larger than a standard microscope’s red reflex. This allows the surgeon to operate without adjusting the microscope when the eye tilts or shifts. A large, vibrant red reflex can increase efficiency and decrease risk for complications.

The ILLUMIN-i technology of the LuxOR gives the microscope its advanced red reflex stability. It incorporates collimated beams of light instead of one focused beam. The collimated beams provide a wider diameter red reflex, even when a surgeon is not in the center of the field or when the eye is tilted. Recently, I participated in a study comparing visualization with a focused beam of light to collimated beams of light. The study showed how far the surgeon can move the eye when using both types of light. The results showed that the microscope could be moved in the X and Y directions about three times farther with a collimated beam before the light dimmed and before a shadow developed, as compared to a focused beam.

A greater depth of focus is also an integral aspect of visualization during cataract surgery. The LuxOR’s objective lens is in a unique position; it is above the light source, which provides a longer focal length that increases the depth of focus without changing the surgeon’s working distance. With the objective lens in this position, there is an improvement in the depth of field. The surgeon can now see more aspects of the eye because they are in focus at the same time. Similar to a red reflex that gets lost when surgeons are not in the center of the field causing the surgeon to move the microscope in the X and Y directions more frequently, if surgeons must constantly refocus the microscope up and down, it can be frustrating and time-consuming. Having to refocus throughout the case is not efficient. Also, if portions of the eye located just beyond the phaco tip are out of focus, it can increase the risk of the surgeon not observing a potential complication.

A stable red reflex and improved depth of focus together create the optimal setting for cataract surgery. When surgeons can achieve and maintain their view of crisp details throughout surgery, they are able to perform the most seamless surgery possible.

Incorporating an upgraded system

The expense of incorporating an upgraded microscope into a practice may be a drawback for some surgeons. They often use the same microscope for many years, because microscopes tend to last a long time and they are accustomed to the view. Some surgeons also wonder if there is a learning curve when using a
new microscope like the LuxOR, because they see details they have never seen before and they have learned to judge depth based on when the instruments go out of focus. The LuxOR provides crisp detail that, for instance, may distract a surgeon who sees leftover lens epithelial cells on the undersurface of the anterior capsular rim for the first time. They have never observed this leftover debris with their older microscope and may not know how to handle the situation. Ultimately, however, there is not a learning curve with the newer microscopes; seeing more detail is always better. After a few cases, surgeons usually find it difficult to switch back to their older microscopes.

**Ease of surgery**

Ease of surgery and surgeon comfort are important; in my experience, I perform better when outside factors are not hindering my concentration. The improved visualization of advanced microscopes allows for a better experience because there is overall less stress on the body. Newer microscopes are more ergonomic, and since visualization is improved, surgeons experience less eye strain during cataract surgery. The overall result is that the surgeon is more comfortable throughout the surgical day.

The LuxOR’s LIBERO-XY Communication System is right above my oculars, allowing me to check my settings with a quick glance. Its features make the system more user friendly. For example, the surgeon is able to have the nurse hit the reset button on the touch screen to reset the parameters when he or she sees the X/Y near its limits. The LIBERO-XY allows the surgeon to reset everything at once, reset just the X/Y, the focus or the light source to the original settings and the magnification. I generally do not need to reset any of the parameters during the case, but, at its conclusion, I step on the foot pedal and it recenters the focus and brings me back to the original settings. This is a convenient feature because surgeons do not have to take the time to manually prepare the settings before each case. Although an easily accessible touch screen and wireless foot pedal are not the most important aspects of a surgical microscope, these features make the system more streamlined and user friendly.

Additionally, with advanced microscopes, surgeons have the opportunity to incorporate new technologies such as aberrometry or 3-D viewing. They will also be able to use the LuxOR in conjunction with the up-and-coming VERION system (Alcon Laboratories, Inc.), which streamlines scleral vessel registration, communicates real-time information and incorporates more accurate preoperative planning and toric alignment. Combining the most advanced tools will produce the most efficient, highest quality cataract surgery possible.

**Patient safety and efficacy**

The main reason complications occur with older microscopes is because surgeons cannot see the details of surgery occurring at all levels of the eye. When visualization is compromised, the surgeon is not informed well enough to react accordingly to each change. Newer microscopes provide a more detailed view. For instance, surgeons were never able to see the debris on the anterior and the posterior capsule well enough to remove it, and consequently there were higher rates of inflammation, which can cause increased IOP early on as well as higher rates of posterior capsule calcification. Now that surgeons can see the debris, they can polish it from the capsular bag.

There are no studies that show that newer microscopes are safer for patients. However, intuitively, if the surgeon can see the eye better, see debris that should be removed and have a stable red reflex even when the eye is tilted, then surgery should be safer. I find that the LuxOR microscope does this and more. I can see every detail without having to focus the microscope up and down and left and right during the case, I am more efficient in the operating room. Although speed is not the most important factor, if a surgeon can operate in a shorter period of time more safely, that translates into increased efficiency and more patients per day.

**Conclusion**

The best way to decrease the risk of complications is to better visualize the entire eye during cataract surgery; therefore, a high-quality surgical microscope is vital for ophthalmic practices. The view through the LuxOR microscope allows surgeons to achieve detailed visualization and improves ease of surgery, which ultimately leads to patient satisfaction and successful outcomes.

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Larger depth of focus increases surgical efficiency

Michael P. Jones, MD

Depth of focus is a key aspect of an ophthalmic surgical microscope that affects visualization of the posterior and anterior chamber, and impacts the overall efficiency of cataract surgery. Depth of focus is defined as the range of distance between the nearest and farthest points that are clearly defined in a view through a microscope. The objective lens of a microscope focuses at one distance at a time, and sharpness gradually decreases on each side of the focused distance. In ophthalmic surgery, depth of focus is the range of surface on which surgeons can focus the microscope while performing surgery, without moving the microscope up or down.

Focal length

One of main contributing factors to depth of focus is the focal length of the microscope. The focal length is determined by the distance of the objective lens from the object being viewed. The focal length normally coincides with the working distance of the microscope, since the objective lens is usually the last part of the optical viewing system. If a surgeon's working distance is 175 mm, that is also the focal length of the microscope.

With the introduction of the LuxOR Ophthalmic Microscope (Alcon Laboratories, Inc.), the focal length of the microscope is increased because the objective lens is placed higher in the optical system, increasing the distance of the objective lens from the patient. While standard microscopes place the objective lens below the light source, the LuxOR places the objective lens above the light source, increasing the focal length by 60 mm while maintaining the surgeon’s traditional working distances of 175 mm or 200 mm.

Surgical efficiency

With a standard microscope, surgeons traditionally adjust the focus of the microscope through out cataract surgery. First, the surgeon focuses on the most anterior part of the eye, setting the microscope at a high focal point. Further into surgery, the surgeon usually lowers the focus to create capsulorrhexis. Then, while breaking up the cataract, the surgeon lowers the focus even more. During cortex removal, the surgeon then lowers the focus down to the posterior capsule.

Increasing the depth of focus offers several advantages to the surgeon, such as visualization of multiple regions of the eye simultaneously, reducing or eliminating the need to refocus during the case. The increased focal range allows surgeons to set the focus at the beginning of surgery and maintain that same position for all their surgical steps without having to refocus with the foot pedal.

Another advantage of an increased depth of focus is being able to immediately address a complication if one occurs. Recognizing the complication early on is often what leads to a good outcome. If there is a small tear in the posterior capsule, the surgeon is able to
visualize it right away and can address the situation sooner with an increased depth of focus.

The increased depth of focus offered by the LuxOR can be unsettling for some surgeons at first, because they have adapted their technique to the limitations of their traditional surgical view. They have used the limited focus range to gauge the depth of their instruments; they are accustomed to their instruments going out of focus when they reach a certain depth. Fully adapting to the new view can happen gradually after a few cases.

**Depth of focus and red reflex**

In terms of using an ophthalmic microscope, depth of focus refers to how often surgeons have to zoom in or out at different layers of the eye during surgery. The red reflex is similar, but its view is adjusted by moving the microscope along the X/Y axis to achieve and maintain a red reflex zone that illuminates the eye.

The LuxOR’s proprietary placement of the objective lens above the light source not only increases the depth of focus but also delivers a brilliant red reflex that is 6 times larger than a standard microscope. The placement of the objective lens also creates three collimated, nonfocused beams of light that generate a large, stable red reflex that is easily maintained, even with eye movement. Ultimately, the illumination technology of the LuxOR produces high-quality detail recognition and contrast because of its depth of focus combined with its red reflex stability.

**Conclusion**

Successful outcomes depend heavily on good visualization. When surgeons can achieve high-quality visualization, they are less likely to make mistakes and more likely to feel comfortable during surgery. With the LuxOR, they can distinguish the depth of the cataract more accurately because all the key structures of the eye are in focus. A surgeon can notice whether fragments remain on the posterior capsule without having to readjust focus.

The three collimated beams of light of the LuxOR, combined with its positioning of the light source below the objective lens, create a superior depth of focus. Upgrading to this new system is comparable to upgrading from a standard-definition television to a high-definition television; people did not realize how many details they were missing when they were using the standard version. The visualization with this system is much better, and that is what makes it such a powerful instrument; there is high-definition visualization of all parts of the eye during all phases of surgery.

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John P. Berdahl, MD
The LuxOR's depth of focus is deeper and broader than other microscopes. Sometimes such a depth of focus requires some adjustment for surgeons, because they must adjust to viewing multiple levels of the eye simultaneously and at an increased focus. They are simply seeing more details than they are accustomed to with a standard microscope. However, a greater depth of focus is a significant improvement, because surgeons do not have to accommodate to it quite as much during surgery. They do not have to re-adjust the microscope multiple times, because the depth of focus provides clear visualization throughout the procedure.

David M. Lubeck, MD
The optics of the LuxOR microscope have remarkable depth of focus, significantly decreasing the need to refocus during anterior segment surgery. In most procedures, there is clarity from the corneal dome through to the anterior vitreous cavity without adjusting focus, which is a quality that I have not experienced with other microscopes. This consistency in visualization enhances the quality, ease, and efficiency of surgery.
Red reflex stability is one quality of a microscope that is integral to precise visualization during ophthalmic surgery. The red reflex is the reddish-orange reflection from the retina that is observed through an ophthalmic surgical microscope as coaxial light passes into and then back out of the eye. Its stability is defined by how even and bright the red illumination is across the entire working diameter within the pupil, no matter where the eye moves or is directed during the procedure. In cataract surgery specifically, the majority of visualization is derived from indirect illumination. That is, visualization is created by shadows and contrast that are created by lens material altering and being highlighted by the red reflex. A brilliant red reflex is one that creates the highest degree of contrast, edge definition and detail shadowing within the cataract. The stability of the red reflex, to a great extent, determines how efficiently and safely the surgeon can manipulate the cataract and work within the capsular bag.

Causes and effects of a poor red reflex

Many factors within the eye can cause a poor red reflex, darkening areas of the intra-pupillary surgical field that need to be visualized for surgery. Achieving a stable red reflex is particularly challenging in patients with small pupils, because maintaining coaxial illumination is structurally more difficult. Significant eye movement during surgery can create havoc with the red reflex because when the eye shifts off center, coaxial illumination can again be difficult to maintain. The surgeon must then take time to re-adjust the microscope so the correct illumination is achieved. Dense lens opacities and corneal haze can interfere with the red reflex and surgeon’s view, as well. External factors such as the position of the microscope can also cause a diminished or unstable red reflex. Illumination optics are changed by tilting the microscope. Movement of the eye away from the point of perfect optical focus in the Z axis or of centration in the X/Y axes can further affect the quality of the red reflex by limiting coaxial light reaching the retina. Therefore, it is imperative that a microscope provides not only a bright red reflex, but one that offers a stability that can best accommodate all of these situations.

When the red reflex decreases because of eye movement or change in the position of the microscope, certain phases of cataract surgery become more difficult and potentially dangerous. For example, creation of round and appropriately sized capsulorrhexis is more difficult with a diminished red reflex. It is more difficult for the surgeon to determine where within the cataract the phaco or I/A tip is being placed. Most importantly, without consistent illumination, it is more difficult to see and judge the position of the posterior capsule during different phases of the procedure. When surgeons do not have a consistent view of the posterior capsule, the risk of rupture increases. If posterior capsule rupture does occur in the absence of a good red reflex, the surgeon will be less able to recognize and stabilize it early enough to prevent a larger, more complicated tear.

Benefits of a stable red reflex

To prevent intraoperative complications like posterior capsule rupture, surgeons need a microscope that provides a stable and even red reflex. The red reflex created by the LuxOR Ophthalmic Microscope (Alcon Laboratories, Inc.), is not affected by pupil size, eye movement, lens tilt, microscope tilt or centration. Its red reflex is significantly more consistent and stable than any microscope I have previously used; this is largely because its unique illumination optics have a broad coaxial light source for both of the surgeons eyes (Figure 1, Figure 2). This provides such consistent visualization that the surgeon is not required to re-adjust the microscope at any point during surgery to maintain the red reflex.
Consistent visualization of elements in the eye improves every step of cataract surgery, such as making corneal incisions, dividing nuclear material, removing of cortex, complete cleaning of the anterior and posterior leaves of the capsular bag, placement of the IOL and removal of viscoelastic. Consistent visualization is especially essential when performing capsulorrhexis or other complex capsular maneuvers. Creation of the capsulorrhexis is best judged by the shadow it's edge creates in the red reflex. As the red reflex becomes brighter and more even, the capsular edge becomes more distinct. This greatly adds to the surgical ease in performing centered and appropriately sized capsulorrhexis in all types of cataracts.

**Conclusion**

Cataract surgeons rely on the red reflex and depth of focus to provide visualization for the most critical steps of surgery. Therefore, these qualities in an operating microscope can affect the efficiency and success of each procedure. The advanced illumination and optical systems of the LuxOR provides superb visualization throughout each case and does so without requiring intraoperative re-adjustment of the microscope position. This exceptional improvement in red reflex stability and focus ensures a satisfying experience for the surgeon and the best opportunity for successful outcomes.

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John P. Berdahl, MD

The LuxOR has the most impressive indestructible red reflex. The amount of XY and focus surgeons can achieve with its LIBERO-XY Communication System while still maintaining a red reflex is remarkable. Surgeons can see a level of detail that they were never able to see using past models.

Michael P. Jones, MD

The red reflex is similar to depth of focus, but the red reflex is adjusted by moving the microscope left or right, or up or down to achieve a large, vibrant zone that illuminates the eye. The LuxOR microscope's three collimated beams of light create a red reflex zone that is six times larger than a standard microscope. Surgeons do not have to worry about focusing up or down and do not need to move the microscope left or right if the patient’s eye moves, because the red reflex zone is so large. Not having to re-adjust the microscope in any direction makes surgeons more efficient in the operating room.
Although surgical microscopes are essential for both cataract and retina surgery, they play a different role for each procedure. While both types of surgeries require detailed visualization, retina surgeons have a more stringent and challenging set of requirements for a microscope. For example, the microscope’s illumination system must provide both a broad view with diffuse illumination and a narrow, intense view with perfect clarity and appropriately intense illumination. Retina surgeons often have to switch back and forth between these two types of views depending on which phase of surgery they are performing. Ultimately, clarity coupled with a wide spectrum of views is the optimal condition for retina surgeons when using a surgical microscope.

**Visualization in retina surgery**

The main challenge for attaining ideal visualization through a surgical microscope for retina surgeons has always been to not only achieve clear visualization, but also appropriate visualization. By definition, structures in the retina (like the vitreous and scar tissue) are interconnected with other structures located deeper in the eye. The vitreous contains strands that are connected to the retina beyond what the surgeon can see. When the surgeon is working toward the front or in the middle of the vitreous cavity, the surgeon can, and often does, have remote tissue effects. Therefore, retina surgeons must see all of the intraocular structures clearly in a broad fashion.

Retina surgery can be divided into two sections. The first part is removal of vitreous and broad fibrous tissue. During this phase of surgery, the surgeon needs good visibility in a specific area and but also in the surrounding structures of the eye, which is where broad illumination is necessary. For the second part of surgery, surgeons work in a specific, small area when removing fine tissue, such as the internal limiting membrane (ILM). In this situation, a broad view is not necessary, but an extremely focused, clear view with appropriately intense illumination is necessary. The best microscope system is going to allow the surgeon to have access to both views, and that is what makes the LuxOR Ophthalmic Microscope (Alcon Laboratories, Inc.) such valuable tool for retina surgeons.

Depth of focus also plays a role in visualization for the retina surgeon. The LuxOR’s proprietary placement of the objective lens above the light source gives the microscope a longer focal length without changing the surgeon’s normal working distance. The longer focal length also provides a greater depth of focus than standard microscopes. The increased depth of focus in combination with the great resolution of the LuxOR’s optics enhances vision for both phases of retina surgery. Having a good depth of focus is an important factor in obtaining the diffuse view for the first phase of surgery. The surgeon needs to constantly and accurately gauge the tissue location in a...
three dimensional fashion. Misplaced movement can cause complications such as retinal trauma or iatrogenic tears.

While depth of focus is important, having high-quality resolution is also important in the second phase of surgery. In this case, the surgeon does not need a large-area view, but needs to be able to visualize a narrow area of focus where it is a matter of microns that determine whether the ILM is peeled successfully, or if iatrogenic tears occur. Therefore, an ideal microscope would allow for both a wide, diffuse view as well as a narrow, focused view.

Retina versus cataract surgery

Retina surgeons tend to encounter visual obstacles more frequently than cataract surgeons. For example, when retina surgeons perform surgery on a patient with diabetes, there is often blood present in the eye due to damaged blood vessels, which can also cause formation of scar tissue. Consequently, the surgeon must attempt to remove delicate tissue while blood is present.

Retina surgeons also encounter unexpected occurrences like bleeding or a retinal tear, which surgeons must be able to see and respond to quickly during the procedure. Perhaps most challenging, retina surgeons have to remove the ILM in several different surgeries. The ILM is a very thin, delicate and transparent tissue that can be difficult to see. There are many surgeries that require removal of the ILM, such as a macular hole, macular pucker and proliferative vitreoretinopathy (PVR) surgery. Consequently, clear visualization of fine, delicate tissue has become more important now than ever before for the retina surgeon.

AMP technology

Another patented advantage of the LuxOR specific to retina surgery is its AMP feature. A piece of glass is traditionally used in cataract surgery to direct light downward, creating a brilliant red reflex. Because retina surgeons do not need a red reflex, the AMP technology allows the surgeon to remove the piece of glass that redirects a portion of the light that returns to the surgeon’s eyes. This benefits retina surgeons because the glass does not deflect light coming from light probes in the patient’s eye.

Patient satisfaction and outcomes

Patient outcomes and satisfaction are determined by the ability to perform surgery efficiently and safely. A microscope does not have a measurable, direct impact on patient outcomes; however, that does not mean it is not an important factor. There are many intangible aspects of surgery that are as important, if not more important, than those that are tangible. A good example is the use of an ultra-fast cut rate.

Safety is difficult to prove in surgery because the incidence of complications in ophthalmic surgery is low. Therefore, a large sample size is needed to achieve statistical significance. That kind of study is unlikely, which is why there are important but intangible factors. However, it is intuitive that surgeons can clearly see the tissue planes and perform surgery more safely and efficiently as a result. This has an important impact on patient outcomes. The fact that it is intangible does not lessen its importance or significance.

Conclusion

Visualization is important in any ophthalmic surgery; however, retina surgery provides particularly specific challenges. The LuxOR microscope allows retina surgeons to alter their view from broad and diffuse to narrow and intense, which optimizes visualization during each phase of surgery. This dual capability helps achieve the appropriate visualization retina surgeons continually seek and sets the stage for a successful outcome.

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Optimizing patient safety and outcomes with advanced surgical microscopes

John P. Berdahl, MD

One of the most important factors in choosing the right surgical microscope is its ability to optimize surgery by improving patient safety, satisfaction and outcomes. A microscope that can provide visualization throughout cataract surgery creates the foundation for a successful outcome. When surgeons can maintain clear visualization for all phases of cataract surgery such as capsulotomy, polishing of the capsular bag and fragment removal, they can prevent complications and sustain patient comfort by keeping surgery time brief.

An advanced microscope can help the surgeon anticipate potential complications. The LuxOR Ophthalmic Microscope (Alcon Laboratories, Inc.), in particular, helps surgeons clearly visualize each part of the eye with its vibrant red reflex, so surgeons are able to target and prevent complications (Figure 1). If a complication occurs, then surgeons are able to stabilize it as quickly as possible, because all parts of the eye are illuminated well enough for them to observe and manage the complication without diverting their attention to the microscope settings.

Impact of visibility on surgical outcomes

The quality of surgery depends on how well the surgeon can view the eye; the surgeon must be able to achieve good visualization throughout each phase of surgery to produce good outcomes. Clear visibility is also essential for creating the capsulotomy, especially in patients who have dense cataracts (Figure 2). Creating a capsulotomy on a dense nucleus requires more attention and effort, so it is essential that the surgeon focus less on ma-
Manipulating the microscope and more on creating the capsulotomy in these cases.

One aspect of surgery that the visualization of the LuxOR microscope has been beneficial is when using intraoperative aberrometry. The aberrometer diverts some of the light provided by the microscope, therefore, using it in combination with an older microscope inevitably leads to poor visualization. When surgeons obtain measurements with intraoperative aberrometry, they may have to immediately alter their surgical technique, such as responding to changes in astigmatism when placing limbal relaxing incisions or changes in refractive error by choosing a different IOL. If surgeons are implementing the latest aberrometry technology, then they should also implement an advanced microscope to achieve high-quality illumination and guarantee the best results for the patient.

The LuxOR can also provide crisp visualization for other types of procedures, like glaucoma surgery. For example, it can provide highly magnified views for the surgeon during intraoperative gonioscopy, where clear visualization of the anterior chamber angle is particularly important (Figure 3).

The LuxOR allows the surgeon to maintain clear vision throughout surgery, which can potentially lower the risk for intraoperative complications such as trauma to the corneal endothelial cells associated with dense cataract removal. Perhaps most importantly, surgeons must avoid a posterior capsular tear while polishing the capsule. To do so, the surgeon must recognize a small tear early on and prevent it from becoming larger. Additionally, it is important for surgeons to have clear visualization at the end of surgery when to ensure removal of all nuclear fragments to avoid complications such as glaucoma, corneal edema and uveitis.

**Patient and surgeon comfort**

Surgical microscopes must provide good visibility for the surgeon and minimal discomfort for the patient so as not to interfere with the flow of surgery or the patient’s overall experience. One source of discomfort for patients is the bright light shining into their eyes, which is associated with standard microscopes. Because the LuxOR has a brilliant, indestructible red reflex, the surgeon can use a lower light intensity rather than a bright light, making surgery more tolerable for the patient while still providing the same level of red reflex for the surgeon (Figure 4).

Figure 3: Regular and high-magnification views of intraoperative gonioscopy through the LuxOR Ophthalmic Microscope,

*Source: Berdahl JP*

Figure 4: The LuxOR Ophthalmic Microscope maintains a great red reflex even though the surgeon has started to divide the IOL.

*Source: Berdahl JP*

An ophthalmic microscope must also be comfortable for surgeons to sit in so they do not have to adjust their ergonomics or technique to accommodate for their discomfort. Performing surgery in an uncomfortable position may lead to mistakes...
or the use of an unfavorable approach. When the surgeon and patient are as comfortable as possible, the surgeon is able to focus solely on the surgery, which can reduce surgical time. Ultimately, advanced microscopes like the LuxOR serve to enhance the surgeon’s vision without interfering with his or her surgical approach, thus generating a more efficient and safer surgery.

**Conclusion**

It is essential for surgeons to visualize all of the critical structures in the eye: the anterior capsule, the posterior capsule, the cornea, the incision and any nuclear fragments that may be present. Viewing each of these components in focus at the same time can impact patients’ outcomes. Surgeons should not be left to wonder whether the zonules are weakening or whether the posterior capsule is still intact; they should be able to see how each of these components behaves at all times. One of the aspects of the current microscope technology in ophthalmology is that surgeons have exceptional visualization and, therefore, can manage complications in time to achieve a successful outcome.

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**PERSPECTIVE**

Michael P. Jones, MD

Two elements of ophthalmic surgical microscopes greatly affect patient comfort: the light source and length of surgery. The light source of the LuxOR provides high-definition visualization without increasing light intensity. Because of the great view offered by LuxOR, a surgeon will normally lower the light intensity of the light source. Patients are more comfortable with that set-up because there is a much less bright light shining into the patient’s eye. Additionally, since the surgeon can see more layers of the eye without adjusting the microscope, he or she can perform a more efficient surgery. The more efficient the surgeon is in the eye, the less time the patient is undergoing surgery.
Future Improvements

As ophthalmic technologies become more advanced and refined, surgeons have the opportunity to try new systems and techniques, and think about which changes can further improve surgery. Surgeons are able to learn from experience and look toward the future to contemplate what new tools can affect better outcomes and safer procedures. Though advanced surgical microscopes have greatly improved visualization, there are alterations that can potentially make them even better.

Robert Cionni, MD
In the future, improved ocular designs will change the surgeon’s head positioning, which would increase comfort and, in turn, improve the ease of surgery. The more comfortable the surgeon is, the more he or she can focus maximum attention on performing a successful surgery.

Michael P. Jones, MD
In the future, technological advances will allow communication between how surgeons measure the patient’s eye in the office and what they see under the microscope. Therefore, advancements of the microscope should include an indicator of the exact position to implant a toric IOL and an outline of how large a capsulorrhexis can be. These improvements are on the horizon, so it is almost as if manufacturers have predicted the improvements surgeons would want. Refractive surgeons want outcomes to be as efficient and precise as possible, and the technological improvements that can achieve successful outcomes are already underway.

David M. Lubeck, MD
A new dialogue is needed to determine the features of future surgical microscope systems. It is important that a microscope has an adjustable working distance that allows me, as a taller surgeon, to have a more comfortable and healthier working posture. A microscope system with an improved ergonomic design would address not only the comfort of the patient’s eye, but also the health of the surgeon. Improving the ergonomics of the microscope could also improve operating room staff comfort. For example, further ergonomic improvements to the microscope and its base, including design changes that make the microscope simple to move, set up and manipulate within the operating room environment, would make the physician’s and operating room staff’s experience smoother, healthier and safer.

Pravin U. Dugel, MD
Surgeons will always want improved optics, better illumination and a broader field of view in future microscope models. Beyond that, I would like to see the integration of the microscope with the vitrectomy machine, the laser and the intraoperative optical coherence tomography (OCT), which would allow me to better image the tissue planes. I also envision being able to seamlessly transmit images and medical information from the office to the operating room. Inside the operating room, I would like that information to be synthesized and shared by the appropriate surgical units (eg, vitrectomy machine, laser, microscope, etc) in a seamless fashion; that is how the system can be truly integrated. Beyond the improvements of the microscope itself, I would like to see the microscope not just serve as a microscope, but as an integral component of the operating room.

John P. Berdahl, MD
It would be ideal if future microscope models could have a real-time, heads-up display that shows what is going on in the eye environment at the time of the surgery. Another beneficial improvement would be if the microscope could help surgeons understand how astigmatism is being affected and help observe refractive error. I would also like to see aberrometry integrated into a microscope.