Getting the best from your slit lamp

In the first part of a series looking at enhancing your slit-lamp technique, **Steve Thomson** discusses equipment

For almost 100 years the slit lamp has been used clinically primarily as a device that allows the user to observe the transparent structures of the eye. In addition it can provide a magnified, stereoscopic view of almost the entire eye. The recording of the image observed through the slit lamp was first introduced over 40 years ago but these analogue photo-slit lamps were usually the domain of the skilled ophthalmic photographer. The recent digital revolution has seen a switch from conventional film to digital media and has increased the availability and affordability of imaging slit lamps. This resource aims to assist those new to slit-lamp imaging and act as a reference that may help improve the quality of the images they acquire.

Most modern slit lamps have the ability to be adapted to capture images. These images can be produced from an eyepiece-mounted camera at the entry level to a full photo-slit lamp at the opposite end of the scale. Most of the instruments are capable of producing images of acceptable quality, but some configurations are more capable than others. This short series will concentrate on the illumination technique and some of the technical settings of the slit lamp that will enhance your clinical documentation of the eye and increase your imaging expertise.

As a clinical instrument the slit lamp comprises a biomicroscope and slit illuminator. The biomicroscope produces a three-dimensional image of the eye and the view is aided generally by focused light from the illuminator column. The depth of field observed with the slit lamp is relatively small and this is due to the need for efficient optics that have the ability to transmit low levels of light. In use, and to compensate for this shallow plane of focus, users tend to scan the image where their own visual system compensates. Further enhancement is perceived due to stereopsis. When an image is acquired it is only a brief moment of this examination that is captured in two dimensions. This is the main reason why slit-lamp images can be disappointing when compared to the slit-lamp view. Learning to view the image monocularly prior to capture, through the ocular to which the camera is attached will help achieve better focus and improved composition.

Figure 1 Haag-Streit BX Photo Slit Lamp

Figure 2 Using a correctly focused eyepiece with reticule can reduce focus errors

A further source of focus error can be due to a combination of refractive error and accommodating while viewing the image. If your images seem consistently out of focus this is the likely cause. The focus can be improved by compensating this error in the eyepiece lens. This ensures that the plane of focus of your retina is at the same level as the camera sensor. This is best achieved by using an eyepiece that contains a reticule, but can also be checked by using a focus check rod and a very narrow slit.

One of the main factors that limit the quality of some images is the amount of light energy made available for the sensor to record. This is far more important than the number of individual pixels that comprise the image and this will be covered in the following section. If simply attaching a digital camera to the eyepiece of the slit lamp worked well, then there would be no necessity for resources such as this.

Equipment

From the outside, most slit lamps look similar and the only apparent difference is perhaps the upright illumination tower of the Haag-Streit (and copy) devices compared to the more compact illumination offered by Zeiss-type instruments. The tower, or Koehler illumination, is said to produce a brighter, more homogenous light than an equivalently powered Zeiss type, but for general imaging this will make little difference.

Many of the more subtle differences cannot be seen from the outside but can only be appreciated when a greater understanding of the instruments is obtained. Previously it was mentioned that light is the main factor in imaging and it stands to reason that a slit lamp that has wider, more light efficient optics may be superior to a device with lower aperture optics. This is important, as to create the captured image only a portion of the light energy reflected from the eye is available to the camera, as this must be shared with the observer. Generally a beam splitter is used for this purpose and for most arrangements a device that sends 70 per cent of light to the camera and 30 per cent to the operator is the best choice. Optimally, a beam splitter that can be switched in and out when required is the best solution. Some advanced beam splitters and camera adapters also have an aperture control that can be used to control depth of field and/or image exposure. These help provide the highest level of control over the creation of the final image.

The slit-lamp bulb is normally either produced by a tungsten or halogen source and providing it is in good condition will not greatly influence the quality of the image. A poor quality bulb or one close to blowing may reduce the light output by as much as

25 per cent. Clinically the tungsten is preferred for viewing as the halogen contains more blue wavelengths and as a consequence there is a reduced amount of detail in retinal imaging due to the less penetrative light. Most camera sensors have the ability to balance for the colour temperature of the slit lamp but if good retinal detail is required then some of the blue wavelengths in halogen illumination must be removed by filtering.

The camera sensor plays an important role in the image quality and this is the technology that has shown major advances in recent years particularly in terms of sensitivity and resolution. However, a common misconception is that the higher the number of pixels, the better the image will be. This statement may hold some truth if we were imaging low contrast, evenly illuminated subjects in bright conditions using a relatively small aperture lens system. In reality when imaging the eye we have the opposite and any digital camera will have problems deciding on the level of exposure.

Slit illumination produces a high contrast subject that is partially illuminated and our area of interest can contain both dark and brightly illuminated portions. Furthermore, both patient tolerance and international standard limit the level of illumination that we can use. This means that a camera with increased sensitivity – an ability to more efficiently record the light photons, is likely to produce a better image than a camera that has lower sensitivity.

The efficiency of the camera sensor is generally related to the individual pixel size and therefore it is likely that if two sensors of equal resolution (number of pixels) are compared, the sensor with the larger pixels will reproduce the subject more faithfully. In practice for slit-lamp imaging, this means that unless an auxiliary flash system is used, the best solution is a compromise between the individual pixel size and the total number of pixels on the sensor.

There are many complete slit-lamp imaging systems available and all can produce images of reasonable quality. The latest have in-built camera systems that can offer a number of advantages over camera attachments as generally these devices have been developed specifically for the slit lamp. The latest camera from Haag-Streit has a unique method of controlling the exposure from a convenient remote module attached to the slit lamp or via the scroll wheel of the computer mouse. Furthermore, on capturing an image the previous 30 frames are also recorded and therefore any micro-saccadic eye movements or blinks do not affect the image and the perfect image can be captured each time. This feature is especially helpful when imaging the retina or when attempting higher magnification images. There are numerous cameras that can be fitted to most current slit lamps and generally they can be a video source that is then digitised via computer or increasingly common, direct digital video. Digital video cameras are cost effective as no expensive computer hardware is required. However, all require some form of driver software and computer hardware.

Figure 3 A device that has wide, light efficient optics will give the best results

Figure 4 Consumer cameras offer an option but results can often be disappointing

Various consumer digital cameras can be used on the slit lamp with differing levels of success. The low cost attracts many users in this direction but choosing the correct camera can be difficult and learning how to use it best on the slit lamp can be time consuming. If this were a simple solution then all vendors would offer this type of solution. However, the introduction of a third optical arrangement of the digital camera lens increases the difficulty of this method.

If the budget will only extend to a consumer digital camera, try setting the focus to manual, focused to infinity and, while holding the camera to the eyepiece of the slit lamp, zoom the lens until the frame is filled. Set the exposure to around 1/30 of a second and if there is sufficient light then the camera should fire when the release is pressed.

Most affordable cameras cannot faithfully record the image we observe though the slit lamp as there is a significant difference in the dynamics of recording the information. Clinically we can easily visualise detail in the bright slit and darker surrounding regions with the benefit of our complex visual system.

Camera sensors have been evolving for only a small fraction of the time it took our vision to evolve and they do not yet have the same ability to distinguish areas of wide luminance change that we can observe.

The dynamic range of some cameras is improving but to help produce a more realistic looking image, and to provide some extra light energy to the sensor, a background, or fill illumination light source can significantly improve image quality.

Background illumination is generally delivered to the eye as diffuse light from a small exit source to minimise reflections. This light is normally variable by means of an aperture control and this variation assists in creating the required balance between slit illumination and background detail. Lower cost background illuminators change the voltage to the bulb, but these should be carefully appraised as changing the bulb voltage will also change the colour of the light.

Creating the correct balance between the background illumination and slit illumination is important. Too much background light over-saturates the slit. Too little background illumination will give good contrast in the slit but the viewer may find it difficult to correctly orientate the image. ●

KEY POINTS

- The correct setting of the eyepiece will help solve many focus problems
- Ensure the colour balance of the camera is calibrated to the light source
- Regularly check the condition of the viewing bulb
- Only some consumer cameras are capable of working with slit lamps
- Background illumination can enhance the image

● **Steve Thomson** is former ophthalmic photographer and is an employee of Haag-Streit AG in Switzerland