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PERSPECTIVES IN REFRACTION

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On Focusing the Slit-Lamp: Part I. An Inaccurate Ocular Setting—What Is There to Lose?

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Abstract. Adjustments of the diopter rings on the slit-lamp oculars compensate for three independent factors: the observer's refractive error, the observer's state of accommodation, and any instrument misalignment. An inaccurate setting of these rings will significantly affect the slit-lamp image quality, as well as the precision and accuracy of slit-lamp mounted lasers, such as are used for retinal photocoagulation, YAG capsulotomy, and laser trabeculoplasty. For each slit-lamp and microscope-related examination technique, photographic technique, and laser procedure, the consequences of an incorrect ocular setting are discussed. Data are presented on the preferred ocular settings of several random observers, highlighting both interobserver and intraobserver variability. Finally, photographs demonstrate the image deterioration that occurs when an incorrect ocular setting is used. It is shown that for younger observers, one's distance refraction is only seldom the correct setting of the slit-lamp oculars, and that on different instruments, one should not be surprised to find somewhat different settings. Examiners are urged to check the accuracy of their habitual setting, if only to find out whether the improvement in image quality is worth the extra bother. (**Surv Ophthalmol 42**:351–354, 1998. © 1998 by Elsevier Science Inc. All rights reserved.)

Key words. argon laser • laser coagulation • optics • refractive errors • slit-lamp

The slit-lamp is probably the single most important diagnostic instrument in ophthalmic practice. The importance of clear focus and a sharp image cannot be overemphasized.[1] In this article we provide data and photographs documenting the image deterioration resulting from an erroneous ocular setting. A companion article (Part II) describes the fading-slit test, a simple test for verifying the ocular setting.

Surprisingly, in each of the following situations, an inaccurate ocular setting causes a totally different, yet significant, disturbance.

1. Slit-lamp examination: a blurred and laterally displaced illumination beam, most noticeable when inspecting the cornea. This topic was discussed in depth in a previous article.[1]
2. Argon laser photocoagulation: a significant error in the actual spot size burn.[2]
3. YAG laser capsulotomy: an inability to simultaneously view both the laser beam and the capsule in focus (when one is in focus, the other is not). Also of significance, while using oblique illumination, is a lateral displacement of the illumination slit, which sometimes causes the laser spot to fall outside the illuminated area of the capsule.
4. Operating microscope: a) blurring the assistant; b) losing focus whenever shifting the zoom set-

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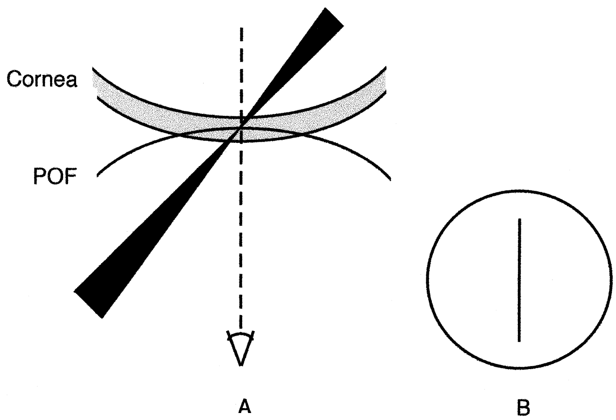


Fig. 1. *A:* Correct setting: a crisp illumination slit. POF = examiner's plane of focus; Cornea = patient's cornea. *B:* A sharp illumination slit, as viewed by the examiner.

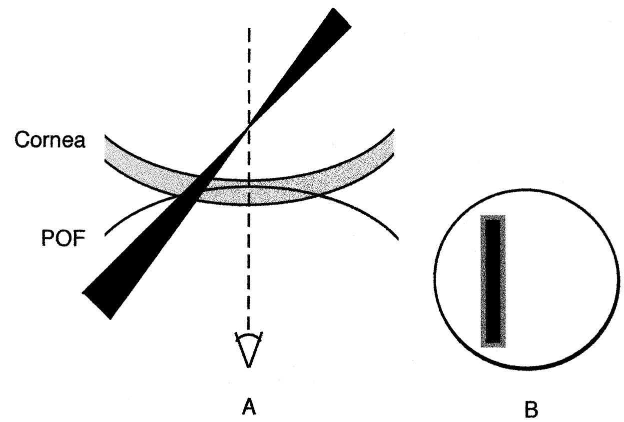


Fig. 2. *A:* An inaccurate ocular setting results in a blurred, thickened and displaced slit. *B:* A blurred illumination slit, as viewed by the examiner.

ting, especially from lower to higher magnification. This will significantly affect the quality of videos taken through the operating microscope.

5. Slit-lamp anterior segment photography: a blurred photograph (both the image and the illumination slit).
6. Slit-lamp videography: blurred video image, especially with higher magnification. In such a case one may have to abandon the oculars in favor of relying on the monitor screen for focusing. This, in turn, may result in suboptimal illumination requiring further readjustments.

The Effect of an Incorrect Ocular Setting on the Sharpness of the Illumination Slit

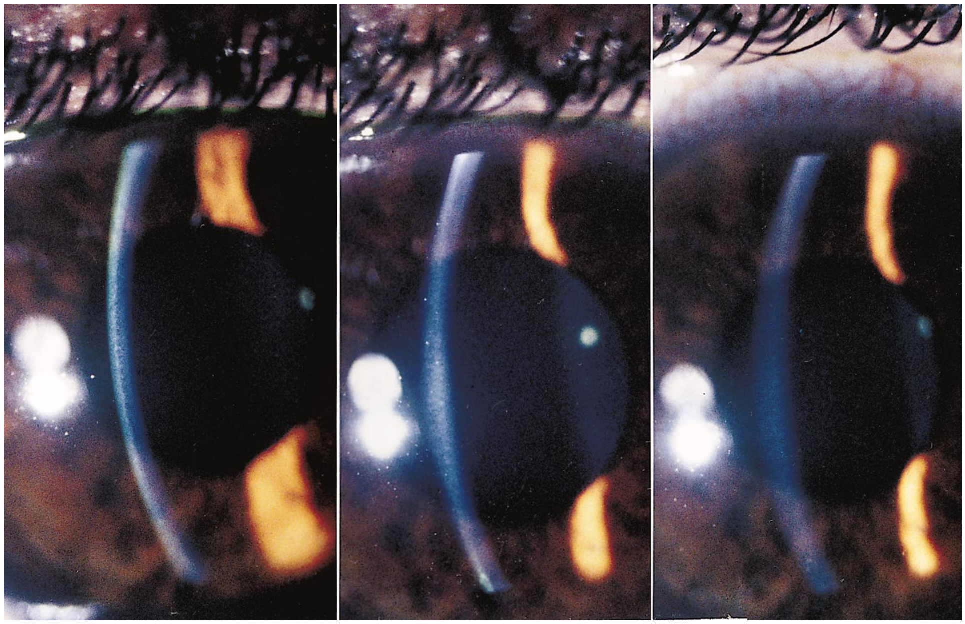
Figs. 1 and 2 illustrate the optical basis for the conclusions drawn in this article. Fig. 1 illustrates a correct setting. In Fig. 2, which shows an incorrect setting, the examiner is accommodating without compensating the ocular setting for the induced anteroposterior shift in the plane of focus. This results in a mismatch (also referred to as noncoincidence) between the image plane and the plane of the focused illumination beam. The only practical method of controlling (collapsing) this interval is through the ocular setting. It is worth mentioning that some of the newer slit-lamp models incorporate an extra control ring, placed beside the illumination mirror, allowing for a continuous and independent adjustment of the illumination focus; however, in the vast majority of instruments the illumination focal plane is factory preset and fixed.

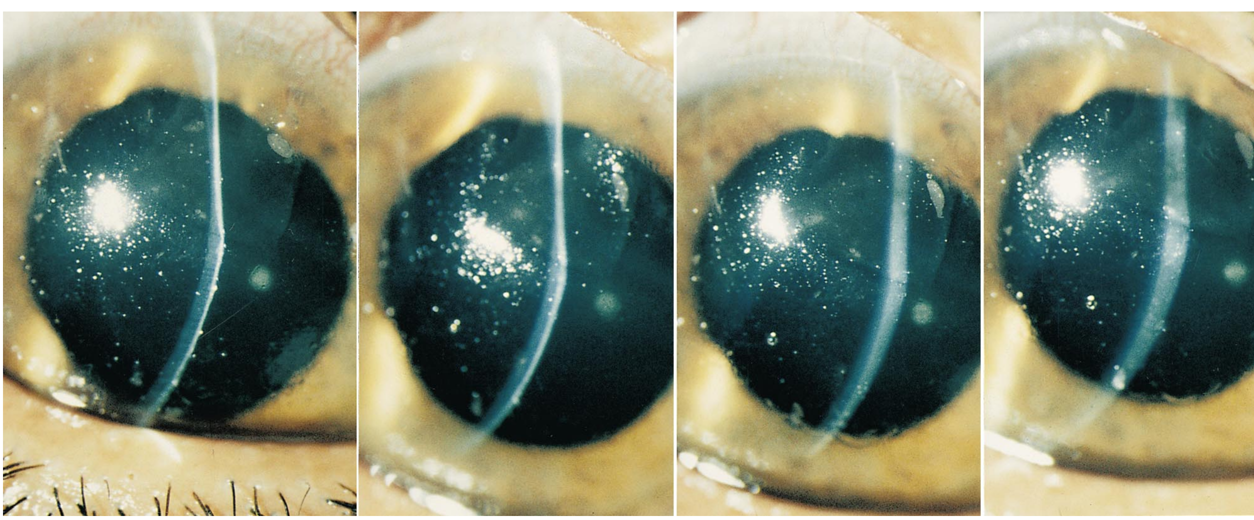
Fig. 3 shows a well-focused illumination slit (always on the left side of each composite photograph) compared to a gradual deterioration of the sharpness of the slit. All of the individual photographs within each composite photograph were taken with the same slit settings (the same slit width and with identical illumination). These photographs demonstrate that whereas the slit shows a gradual deterioration in sharpness (from left to right), the cornea itself (the image) remains in sharp focus throughout the photographs. As evident from these photographs, a sharp slit is crucial for appreciating finer corneal details, such as thickness and contour. In some of these photographs, the maximal offset of the ocular-diopter rings is equivalent to 5 diopters (D) and more, explaining the marked (exaggerated) deterioration seen. However, with some practice (and with high magnification[2]), errors of much smaller magnitude can be recognized clinically.

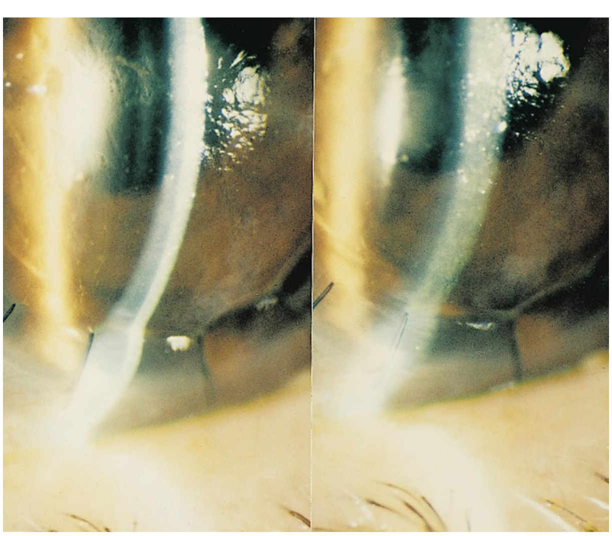
To evaluate variability in ocular settings, we checked a number of observers using the same slit-lamp and then checked each observer using several different slit-lamps.

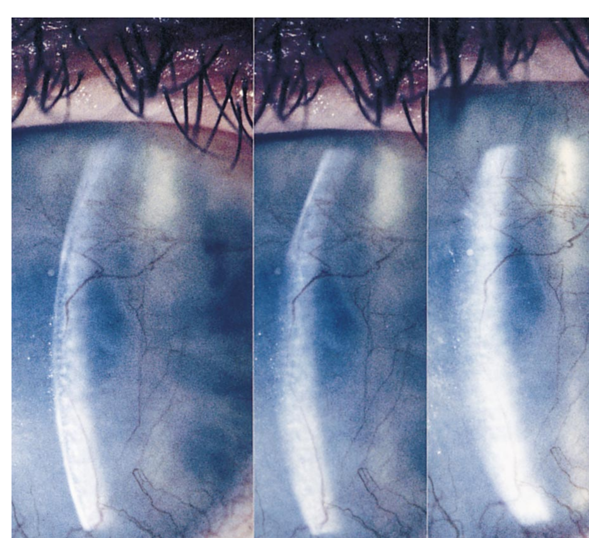
To check for discrepancies between the observer's distance refraction and his (or her) focusing-rod setting, we averaged three focusing-rod measurements from each eye of eight random observers, 28–36

Fig. 3. *Top:* A narrow slit beam transecting a normal cornea. The gradual blurring of the slit (from left to right) results from a gradual increase in the offset of the ocular setting. *Center:* The illumination slit transecting a zone of traumatic thinning of the cornea. Notice that the corneal epithelium (the image) is in perfect focus throughout these photographs. *Bottom left:* The host-recipient interface of this cornea (post PKP) is shown in higher magnification. The slit is significantly wider in this case (as compared to Fig. 3, center), but because the slit is in focus in the left image, corneal thickness and contour can still be clearly appreciated even when a wider slit is used. This is hardly the case with the right image. *Bottom right:* A decompensated cornea, 15 years after ICCE surgery, wearing a soft contact lens.









years in age, with over a year's experience on the slit-lamp. All of them had a distance refraction of no more then 1 D of myopia or astigmatism (or else wearing their distance correction). These measurements were taken at the end of a work day, on two different slit-lamps. The fact that the measurements were taken at the end of a work day is significant, in our opinion, because we found that a more myopic setting is usually favored after long hours of work. The examiners were initially presented with a high plus setting ("fogged") and then requested to rotate the ring clockwise until a comfortable and clear image was first encountered.

The ocular settings found ranged between +0.50 D and −4.50 D, most of them (72%) were in the −1.00 to −3.00 D range. Of a total of 32 readings, only 9 (28%) were in the range −1.00 to +1.00 D. Surprisingly, none of the eight observers were found to have a bilateral zero setting (± 0.50 D) on either slit-lamp. None showed identical readings when checked on two different slit-lamps, while only 30% had an identical reading in the two eyes (measured to the nearest 0.50 D).

A single observer (with an uncorrected distance refraction of −1.00 D) was checked on 13 different slit-lamps of various makes, age, and condition. Three readings per eye were performed and averaged. These three repeated measurements were never identical because of the difficulty of judging an exact end point. Therefore, some of the variability in the results probably stems from intraobserver variability, rather than real differences between slit-lamps.

The difference between right and left eye measurements was 0 or 0.50 D in all but one slit-lamp (note that three measurements were averaged per eye). Measurements ranged between −1.00 and −3.50 D, 73% of which were in the range of −1.50 to −2.50 D. These data suggest that significant differences between individual instruments exist.

Conclusions

The image quality at the slit-lamp is shown to be directly related to the ocular setting. Basing this setting on the observer's distance refraction and on the slit-lamp ocular-diopter scale cannot substitute for the routine use of the focusing-rod, for each eye, whenever one shifts to a different slit-lamp.

Although we feel that time spent in verifying these settings is well invested, we are still puzzled by our observation that the accommodative state of the examiner's eye may, in fact, fluctuate from minute to minute. This is analogous to the fluctuations in one's blood pressure reading, especially during periods of stress.

A second matter for concern, for which we have no definite answer or data, has to do with asthenopia that may result from shifting to a more myopic setting of the oculars for long work hours. This notion is substantiated by our observation that a more myopic setting is often favored toward the end of the day.

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