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Refractions and reflections

Focusing the surgical microscope

*Sergiu D. Socea, MD, Yoreh Barak, MD, Eytan Z. Blumenthal, MD**

Department of Ophthalmology, Rambam Health Care Campus, Haifa, Israel

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ABSTRACT

A well-focused operating microscope addresses several needs that are all secondary to the surgeon's need to see clearly at all times. These needs include: the assistant; the sharpness of the video and monitor; as well as field of view, asthenopia, and focusing issues related to zoom, accommodation, and presbyopia. We provide a practical approach to achieve optimal focus that we call the sloping paper calibration method.

1. Introduction

We take as axiomatic that clear focus is a prerequisite for successful surgical outcome. Focus enables the surgeon to appreciate finer detail, but also allows stereopsis. Unfocused equipment—be it a pair of glasses, the slit-lamp, an indirect ophthalmoscope, or the operating microscope—is also likely to create fatigue over time. Operating through a partially opaque cornea or fogged eye-pieces simulates the downside of working with inadequate focus.

What might occur when a surgeon fails to focus the microscope? Although the surgeon will usually not notice any immediate interference during surgery, both the assistant and the video/TV monitor may be blurred. Changes in zoom will require the surgeon to refocus (an unnecessary step when the microscope is correctly focused), and all involved may experience asthenopia over time.

2. Methods

2.1. Focus as it relates to changes in the zoom setting

Although the surgeon can easily attain focus at any given zoom setting via the foot pedal, this should not be lost each time the zoom setting is changed. Only at one specific diopter setting on the oculars will the microscope maintain focus. When the oculars are set to this sweet spot, the surgeon can move the zoom setting throughout its full range without ever losing focus. At all other ocular settings, a change in the zoom

* Corresponding author: Eytan Z. Blumenthal, MD, Department of Ophthalmology, Rambam – Health Care Campus, P.O.B 9602, Haifa 31096, Israel.
E-mail address: e_blumenthal@rambam.health.gov.il (E.Z. Blumenthal).
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setting will result in the need to refocus. The more distant the ocular eye-piece setting is from the ideal value and the larger the change in zoom, the greater the resultant blur.

2.2. *The zoom-calibration test*

How then, can this sweet-spot be found? Place any target in front of the microscope and focus it with the foot-pedal. Then shift the zoom to the highest setting and focus again using the foot-pedal at that same target. Lastly, shift the zoom to the lowest setting. Without refocusing the foot-pedal focus the microscope using only the eye-piece oculars.

Now you are well-focused. To test that this has actually been achieved, shift the zoom up and down between its extremes and ascertain that you maintain perfect focus throughout. Note the ocular settings. These are the settings that you should operate with from now on, even if they do not match your refraction. Skeptics can now dial in a wrong setting (say, 2 or 3 diopters off in either direction) and verify that now it becomes impossible to zoom throughout the entire range without losing focus.

Of note, it is possible to over-minus oneself during this test. When rotating the ocular setting, dial it from plus diopters towards minus, seeking the first clear view.

2.3. *The sloping paper calibration test*

Focusing the surgical microscope is not just about seeing a clear image, but also makes the plane of interest coincide with the plane of focus. The *sloping paper calibration test* enables the team to align three planes of interest (surgeon/assistant/video camera) with the microscope's plane of focus. The order of calibration must be: first the camera, next the surgeon, and last the assistant.

The sloping calibration test is performed as follows:

1. Construct a sloping piece of paper, either fixing it to a hard supporting surface (Fig. 1), or merely folding any sheet of paper in half, into a tent-like shape. The steeper the slope of the paper and the higher the zoom (by providing a shallower depth of focus[2,4]), the more accurate the test.
2. Note that the paper may contain a line perpendicular to and running down the slope. Bisecting the line should be a shorter line (or dot), marking the plane of interest along the sloping paper. Alternatively, three rows of dots may be drawn on the paper.
3. Place the sloping paper on a tray at a height allowing comfortable viewing through the microscope while sitting.
4. Focus the video monitor by moving the microscope head up and down with the foot-pedal until the plane of interest (the bisected line or the central row of dots) is in perfect focus. Importantly, at this stage do not look through the microscope, look at the monitor. Note that occasionally it may be difficult to fine-focus using the foot-pedal unless the focusing speed (controlled by a button or digitally in the microscope's set-up panel) is slowed.
5. Without moving the microscope or touching the foot-pedal, the surgeon should now look through the surgeon's oculars and focus on the plane of interest using only the diopter rings on the eye-pieces. After this, take a close look again on the monitor to ascertain that the camera is still in perfect focus. Again, to avoid over-minusing, choose the first occurrence of clear focus while rotating the ring starting from a higher plus diopter setting.
6. Last, the assistant focuses their ocular setting on the plane of interest. If the assistant scope has a focusing knob, it can be set to a neutral position. If a neutral position doesn't exist, they cannot directly determine the correct eye-piece setting, since for each setting of the focusing knob a different setting will be found. If this is the case, either dial in the distance refraction or else the setting on the surgeon's oculars. Thereafter, fine-focus using the assistant's focusing knob.
7. Note, previously we described a different approach to determining the surgeon's correct eye-piece diopter setting utilizing the zoom calibration. What should a surgeon do if the diopter setting found with the zoom-calibration technique differs from the diopter setting found on the sloping paper test? Two explanations may underline this discrepancy: The tests might need repeating (as would occur if the surgeon had a change of accommodation between the two tests) or else the microscope is not properly aligned and calibrated (for instance, if the camera is not properly mounted or the mount used is not original). If repeating the tests still results in a discrepancy, the surgeon must choose one or the other. We favor having a perfectly focused video and refocusing whenever changing the zoom setting rather than the other way around.

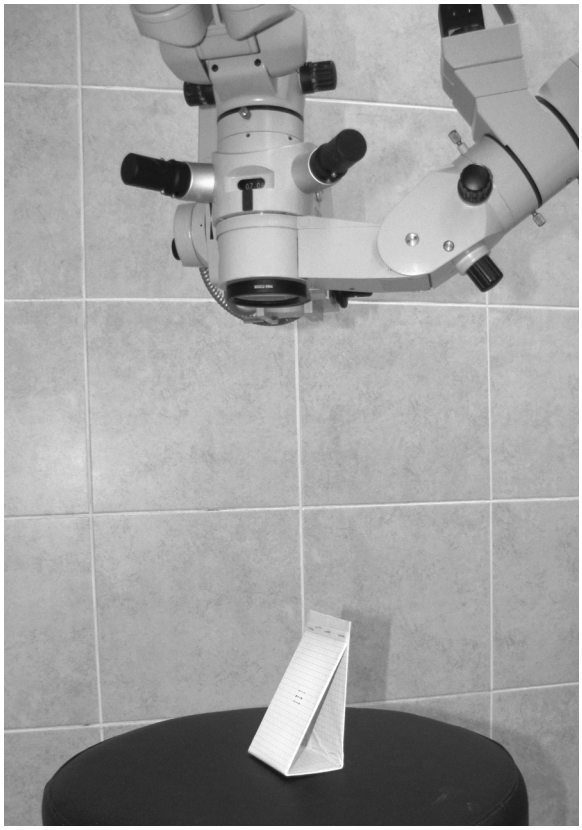

Fig. 1 – The sloping paper used to focus the surgical microscope embedded in cardboard.