

Maximizing OCT Scans

How to avoid common pitfalls with time-domain OCT.

BY TEODORO EVANS, MD; AND LIHTEH WU, MD



Retina Pearls is a column that appears regularly in Retina Today. The purpose of the column is to provide a forum for retinal specialists to share informative and exciting tips or pearls with regard to specific vitreoretinal surgical techniques, diagnostics, or therapeutics. This installment of Retina Pearls features Lihteh Wu, MD, Consulting Surgeon, and Teodoro Evans, MD, Retina Fellow, from the Vitreo-Retinal Section, Instituto De Cirugia Ocular in Costa Rica. Drs. Wu and Evans discuss how to get the best possible information using time-domain optical coherence tomography (OCT).



We would like to extend an invitation to readers to submit surgical pearls for publication in Retina Today. Please send submissions for consideration to either Dean Elliott, MD, (deliott@doheny.org), or Ingrid U. Scott, MD, MPH, (iscott@psu.edu). We're looking forward to hearing from you.

-Dean Elliott, MD; and Ingrid U. Scott, MD, MPH

Since its approval by the US Food and Drug Administration in January 2002, more than 6,000 Stratus OCT (Carl Zeiss Meditec, Dublin, CA) systems have been installed worldwide.¹ It is estimated that 37,000 daily scans are performed in the United States.¹ Based on these numbers, it is clear that OCT has become a valuable adjunct to clinical practice. For example, OCT has been shown to have a higher sensitivity than stereoscopic biomicroscopy for the detection of diabetic macular edema² and provide a more reliable diagnosis than can be achieved with clinical examination in the early stages of macular holes.³ Additionally, OCT has introduced new clinical concepts—such as stage “0” macular hole.⁴

Despite its enormous utility and ease of use, however, the Stratus OCT can deliver inaccurate results if the clinician is unaware of the basic software functions and algorithms. Common errors in the daily use of the Stratus can be classified into two major groups: acquisition errors and interpretation errors.

ACQUISITION ERRORS

Poor scan acquisition can be responsible for an artifact in approximately 11% of topographic maps.⁵ One of the major pitfalls of the Stratus OCT is that image acquisition is dependent on the patient's fixation. This can affect the precision of measurements and can compromise comparison of baseline OCT images with OCT images at subsequent follow-up scans (Figure 1). If the fellow eye maintains fixation, the use of the external fixation LED can be helpful. In cases where the normal anatomy is altered, the expertise of the examiner plays a major role in the correct positioning of the line scan. The software automatically chooses the retinal

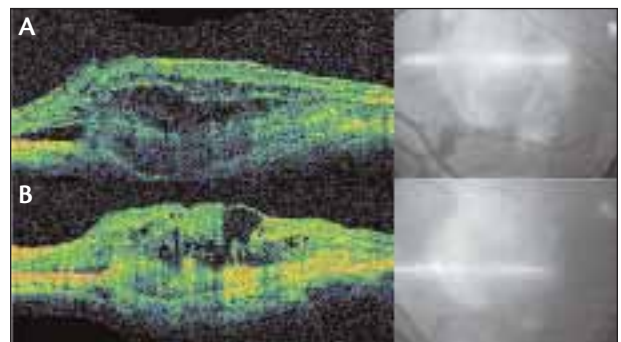


Figure 1. Sixty-six-year-old woman with bilateral neovascular AMD, disciform scar in her right eye and active choroidal neovascularization in her left eye. Visual acuity is counting fingers. OCT image shows the presence of subretinal fluid and intraretinal cysts in both eyes. (A) Baseline substantial disorganization of the retinal structure. The fundus image reveals also the presence of subretinal hemorrhages. (B) One month after intravitreal bevacizumab there is intraretinal fluid and little or no evidence of subretinal fluid on the OCT image, and the fundus image reveals the presence of smaller retinal hemorrhages; however, the line scan does not correspond to the first exam.

boundaries to calculate retinal thickness. If the anatomy is altered, the boundaries are often misplaced, leading to errors in measurement. In these cases, the operator should enter the analysis screen and remove the white line (by unchecking the Layer-On box). Calipers should be switched on (by checking the appropriate box) and placed on the appropriate areas to make a manual measurement.

During image acquisition, a high-quality scan must show a signal strength of five add units or more. Media opacities

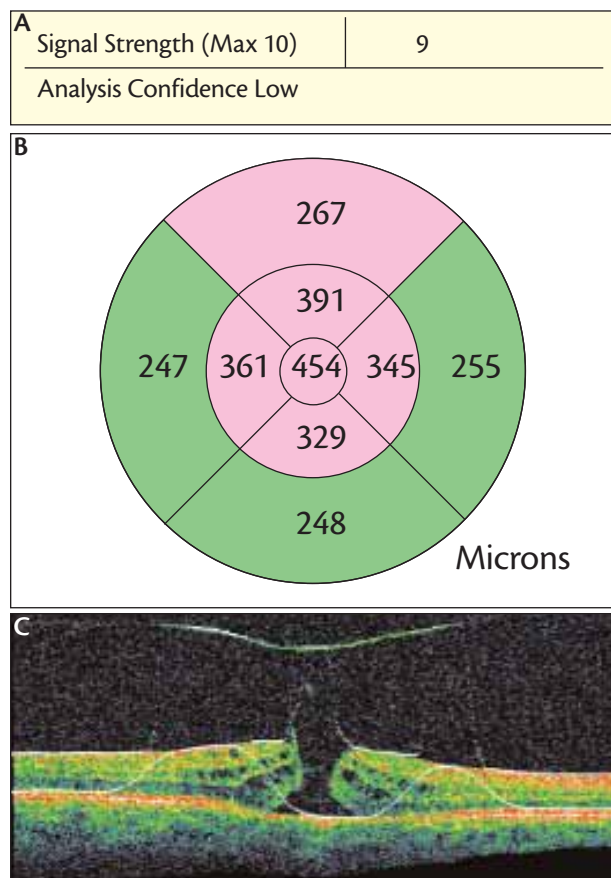


Figure 2. Sixty-two-year-old man with a full thickness macular hole in his right eye. (A) OCT scan with a signal strength of nine add units but an Analysis Confidence Low warning on the scan message box. (B) Retinal thickness tabular report displays a foveal thickness of 454 μm . (C) OCT algorithm lines for retinal thickness demonstrating marked errors with measurements between the internal limiting membrane and posterior hyaloid.

can affect the strength of the signal, resulting in an inaccurate exam. Good signal strength does not ensure a reliable OCT analysis, and the clinician should look for any disparity in the report, as the Stratus software version 4.0 can identify the presence of artifacts (Figure 2).

INTERPRETATION ERRORS

The analyzing software for retinal scans includes an automated correction for movement and an algorithm for retinal thickness measurements, both of which can produce errors during the analysis of the scans.

The purpose of the movement correction is to straighten the retinal pigment epithelium (RPE) layer in case of fluctuations related to eye movement during the scan. This software can mask certain alterations of the RPE related to differ-

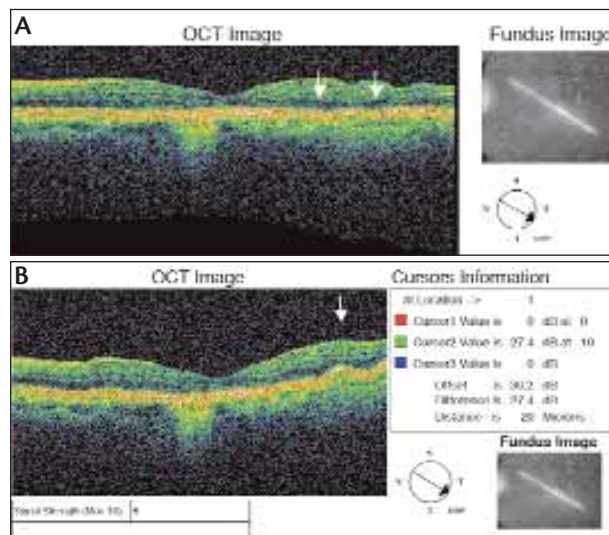


Figure 3. Seventy-year-old man with geographic atrophy and drusen. (A) Processed OCT retinal thickness image shows a flat RPE-choriocapillaris band with an abnormal undulated retinal image (arrows). (B) Scan profile report shows the presence of a normal retinal contour with underlying drusen (arrow).

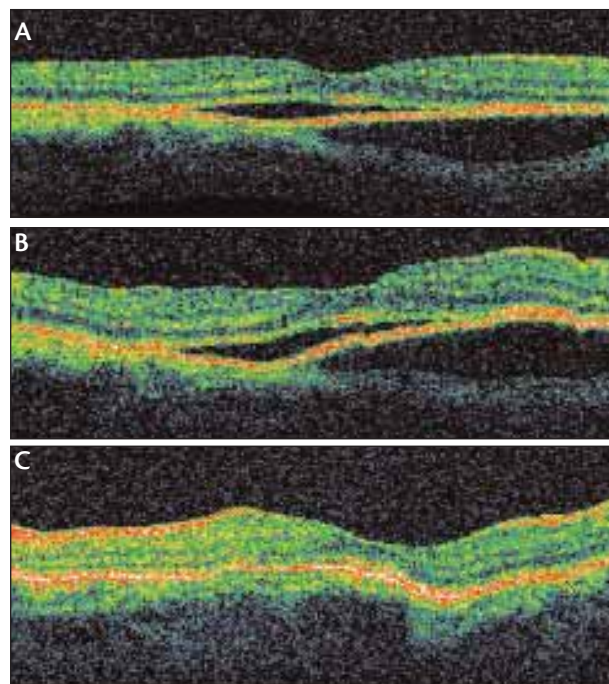


Figure 4. Sixty-two-year-old woman with occult choroidal neovascularization secondary to age-related macular degeneration in her left eye. (A) Retinal thickness report with a flattened pigment epithelial detachment, subretinal fluid, and a normal retinal contour. (B) Scan profile report shows temporal displacement of the retina due to the pigment epithelial detachment. (C) Scan profile report at the 6 month follow-up after intravitreal bevacizumab.

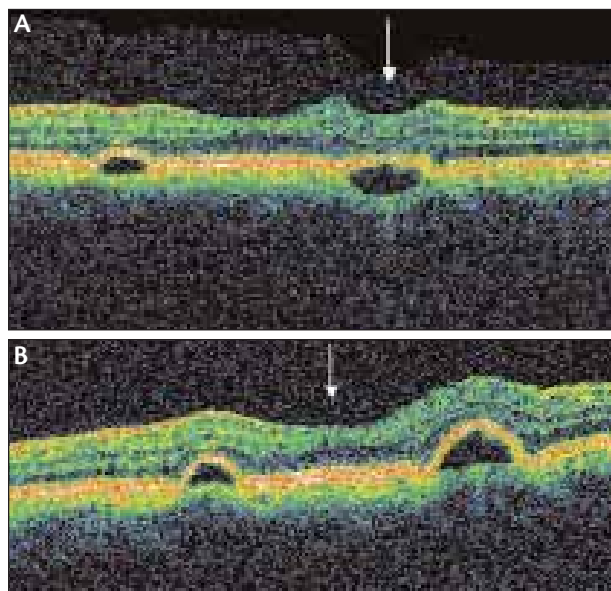


Figure 5. Thirty-year-old man with central serous chorioretinopathy. (A) Retinal thickness report with two flattened pigment epithelial detachments (PED) and a retinal meniscus that can simulate the location of the fovea (arrow). (B) Scan profile report displaying the two PEDs and the correct location of the fovea (arrow).

ent pathologies. In age-related macular degeneration, the movement correction can hide the presence of drusen and alter the retinal contour (Figure 3), or it can flatten retinal pigment epithelial detachments (PED; Figure 4). In such cases, the usefulness of the OCT relies on the detailed information that can be obtained through the OCT images. To override the morphological alterations in the RPE of the movement correction software, we recommend evaluation of the unprocessed images found under the Scan Profile analysis or the Scan Selection section (Figure 5).

In central serous chorioretinopathy the movement correction can also flatten the typical rounded PED or even hide PEDs if they are small (Figure 6).

Measurements of the retinal thickness algorithm are based on the automated capability of the OCT to identify the internal limiting membrane and the hyperreflective band of the RPE-choriocapillaris. Errors related to this algorithm are remarkably common but are generally detected by the software.^{6,7} Conditions that are characterized by the presence of subretinal fluid are related to more severe errors than those with retinal cysts or retinal vascular diseases.⁷ Sadda and colleagues⁸ reported the use of customized software in which the manual measurements were consistent with those delivered with the automated Stratus analysis.

The presence of vitreoretinal traction may cause a failure in the localization of the internal limiting membrane with

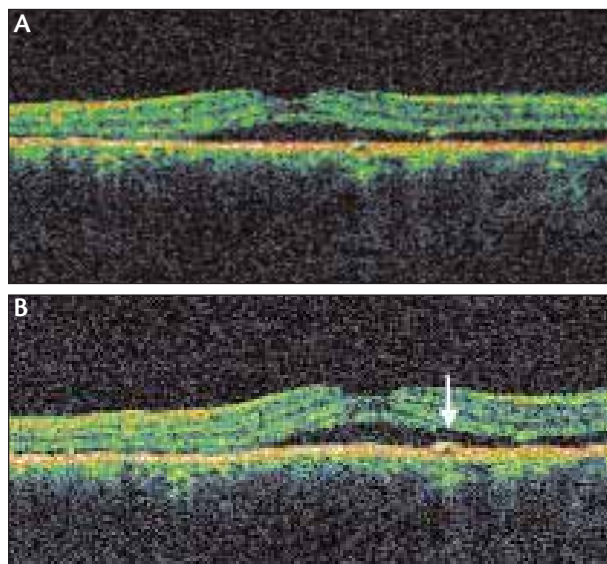


Figure 6. Thirty-eight-year-old man with central serous chorioretinopathy. (A) Retinal thickness report with the presence of subretinal fluid and a flat retinal pigment epithelium (RPE). (B) Scan image revealing a small pigment epithelial detachment (PED; arrow) corresponding to the site of leakage of the RPE.

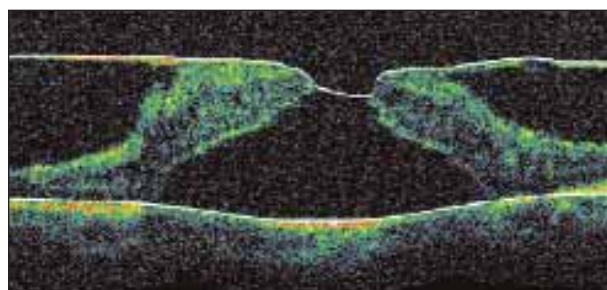


Figure 7. Retinal thickness measurement analysis in a patient with a macular hole and vitreoretinal traction. The automated software shows an error in the placement of the inner layer boundary of the measurement.

misplacement of the inner boundary on the zone of vitreous traction (Figure 7). The presence of a dense retinal hemorrhage can obscure the RPE-choriocapillaris band producing an incorrect interpretation of the outer boundary measurement (Figure 8). Images with poor signal strength are also prone to misdirection of the automated boundary layers of the algorithm.

CONCLUSION

Although errors are common in the image analysis of the Stratus OCT, the current software version 4.0 can detect and warn of their presence. The examiner must search for

(Continued on page 36)



Figure 8. Fifty-eight-year-old man with branch retinal vein occlusion in the left eye. Retinal hemorrhage causing a complete blockage of the signal, obscuring the retinal pigment epithelium-choriocapillaris band for the automated positioning of the inner boundary layer.

(Continued from page 35)

any incongruent information. In many pathologies, the information of the OCT images is very useful; however, images of entities with alterations of the RPE morphology are best evaluated without any analysis protocol. Spectral-domain OCT technology has overcome many of these weaknesses, such as fixation dependence, small scanned area, and thickness measurements, but Stratus OCT can still be a valuable tool in the daily clinical practice if the examiner is aware of its normal functioning and pitfalls. ■

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