

Effect of Ophthalmic Examination Procedures on the Quality of Spectral Domain OCT Images

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ABSTRACT

The authors compare the image quality of spectral domain optical coherence tomography (OCT) images in eyes before and after routine ophthalmic screening procedures. The study population in this prospective case series included 24 patients (45 eyes). No significant difference in OCT scan quality factor was found in the study population pre-screening and post-screening ($P > .05$ for the horizontal, vertical, and raster pattern scans performed in each OCT scan series). Routine ophthalmic screening procedures do not affect the quality of spectral domain OCT images. [Ophthalmic Surg Lasers Imaging 2011;42:e1-e3.]

INTRODUCTION

Optical coherence tomography (OCT) is a noncontact, noninvasive technique for in vivo imaging of the human retina. For accurate and reliable clinical measurements, OCT image quality needs to be adequate. Because OCT is a noncontact technique, image

quality is dependent on a regular ocular surface and clear ocular media.¹ In an office setting, OCT scans are often performed once a patient has undergone extensive screening by an ophthalmic technician; screening tests often include visual acuity measurement, motility testing, visual field testing, intraocular pressure (IOP) measurement, and application of topical anesthetic and dilating solutions in each eye. The purpose of this study is to investigate the effect of preliminary ophthalmic examination procedures on OCT quality measures as assessed quantitatively with the Spectralis OCT (Heidelberg Engineering, Vista, CA).

REPORT

Patients presenting to the Penn State Hershey Eye Center retina service for complete retinal evaluation including OCT imaging were identified prospectively. All participants gave written informed consent for participation in the study. For each study participant, an initial OCT series was obtained on arrival. A second OCT series was obtained after routine preliminary ophthalmic screening procedures were performed. For all patients, ophthalmic screening procedures included visual acuity and IOP measurement and application of topical proparacaine 0.5%, tropicamide 1%, and phenylephrine 2.5% eye drops. Additional screening procedures (such as motility and visual field testing) were performed in selected patients as indicated clinically.

Both sets of OCT scans for an individual participant were performed by the same OCT photographer (TB or JS). A linear mixed-effects model was fit to assess the change in each of the three quality factors for each of three scans (horizontal line, vertical line, and

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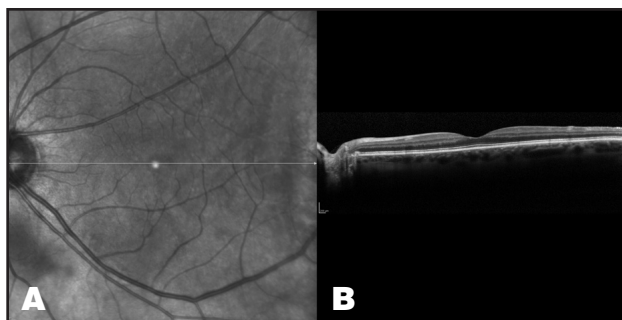


Figure 1. Horizontal line scan obtained by Spectralis OCT (Heidelberg Engineering, Vista, CA) in a patient prior to routine ophthalmic screening procedures. The Spectralis OCT software averages each A-scan signal over 100 frames to reduce signal noise. Adequate subjective image quality is observed in the infrared reflectance (A) and B-scan (B) images.

volumetric raster pattern) obtained by the Spectralis OCT imaging system pre-screening versus post-screening. The quality factor is a measure of signal-to-noise ratio expressed on a scale of 1 to 40 decibels. A quality reading of 25 decibels or more is considered adequate.²

RESULTS

The study population includes 24 patients (45 eyes). Three patients had predominantly monocular retinal disease (eg, branch retinal vein occlusion or macular hole) and therefore only unilateral OCT imaging was performed in these patients. Mean pre-screening horizontal, vertical, and raster pattern scan quality factors were 34.4 (standard deviation [SD] = 4.1), 33.0 (SD = 4.8), and 23.0 (SD = 4.6), respectively. Mean post-screening horizontal, vertical, and raster pattern scan quality factors were 33.4 (SD = 4.2), 32.4 (SD = 3.6), and 22.4 (SD = 4.3), respectively. There was no significant difference between the mean pre-screening and post-screening quality factors for horizontal ($P = .12$; 95% confidence interval [CI]: [-2.26, 0.28]), vertical ($P = .31$; 95% CI: [-2.96, 1.00]), and raster pattern ($P = .29$; 95% CI: [-1.82, 0.57]) scans among all study participants.

DISCUSSION

The effect of ocular media opacities (eg, cataract) on the image quality of OCT has been well studied.³ To our knowledge, and based on a literature search of the MEDLINE database, there are no published studies investigating the effect of ophthalmic clinical examination procedures on OCT image quality.

The air–tear interface contributes most to refrac-

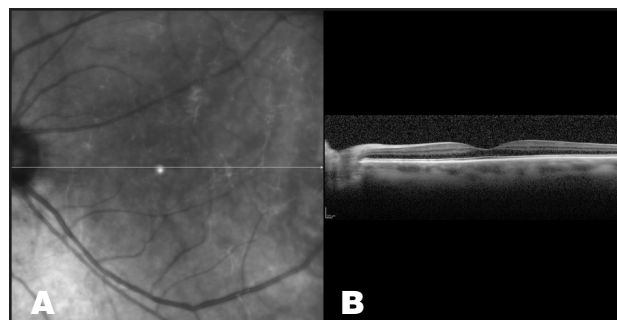


Figure 2. Horizontal line scan obtained by Spectralis OCT (Heidelberg Engineering, Vista, CA) in the same patient as represented in Figure 1 after routine ophthalmic screening procedures. Despite averaging 100 frames to generate this image, a subjective decrease in image quality is observed compared to the pre-screening scan in Figure 1. The infrared reflectance fundus image (A) displays several reflections that obscure retinal details, whereas noise is pronounced in the OCT image (B). The observed difference in image quality is likely secondary to disruption of the patient's tear film after routine ophthalmic screening procedures.

tion of light rays in the eye's natural optical system.⁴ The negative effect of ocular surface exposure on tear film regularity has been well studied.^{5,6} Inadequacy of the air–tear interface may have a negative effect on OCT image quality as a result of near-infrared light scattering.⁷ Stein et al.¹ demonstrated a negative effect of corneal drying on OCT image quality. Routine ophthalmic screening procedures such as visual acuity and visual field testing may lead to prolonged ocular exposure, and mechanical manipulation of the ocular surface may occur during IOP measurement and application of anesthetic and dilation solutions. Representative horizontal OCT scans from a study participant both pre-screening (Fig. 1) and post-screening (Fig. 2) show a subjective decrease in image quality after screening procedures, likely secondary to disruption in tear film regularity.

The results of our study indicate that routine ophthalmic screening procedures have no significant effect on OCT image quality as assessed by the Spectralis OCT imaging system. Horizontal and vertical line scans, as obtained by Spectralis OCT, are high-resolution scans composed of 1,536 A-scans, which are averaged over 100 frames. The raster pattern scan is composed of 512 A-scans, which are averaged over 9 frames. Spectralis OCT software incorporates this redundant image sampling technique to reduce image noise. This technique likely allows for compensation of any minor disruption in the regularity of the ocular surface that occurs with routine ophthalmic screening procedures.

REFERENCES

1. Stein DM, Wollstein G, Ishikawa H, Hertzmark E, Noecker RJ, Schuman JS. Effect of corneal drying on optical coherence tomography. *Ophthalmology*. 2006;113:985-991.
2. DRCR.NET Image Acquisition Protocol. Available at: http://public-files.jaeb.org/drcrnet/Misc/DRCRnet_Heidelberg_Spectralis_Procedures_2009-08-13.pdf. Accessed June 25, 2010.
3. van Velthoven ME, van der Linden MH, de Smet MD, Faber DJ, Verbraak FD. Influence of cataract on optical coherence tomography image quality and retinal thickness. *Br J Ophthalmol*. 2006;90:1259-1262.
4. Courville CB, Smolek MK, Klyce SD. Contribution of the ocular surface to visual optics. *Exp Eye Res*. 2004;78:417-425.
5. Korb DR, Baron DF, Herman JP, et al. Tear film lipid layer thickness as a function of blinking. *Cornea*. 1994;13:354-359.
6. Mengher LS, Bron AJ, Tonge SR, Gilbert DJ. A non-invasive instrument for clinical assessment of the pre-corneal tear film stability. *Curr Eye Res*. 1985;4:1-7.
7. Tutt R, Bradley A, Begley C, Thibos LN. Optical and visual impact of tear break-up in human eyes. *Invest Ophthalmol Vis Sci*. 2000;41:4117-4123.