

Original Research Article

Optovue Optical Coherence Tomography as an Imaging Modality for Scleral Thickness

ABSTRACT

Purpose: To examine the utility of the Optovue optical coherence tomography (OCT) in imaging scleral thickness in patients with a variety of ocular diseases.

Methods: A prospective, single-center study of patients was performed. Repeated measurements of scleral thickness were performed with the Optovue OCT using a line scan 3 mm from the limbus in the inferior nasal and inferior temporal quadrants of each eye. Obtained values were analyzed with regard to precision and reproducibility.

Results: A total of 27 eyes in 16 patients were measured. An average of 3 measurements per location per eye were taken. The mean scleral thickness 3 mm from the limbus was 662 microns. The average standard deviation of the measurements from each location was 54 microns. The boundary of the conjunctiva and sclera was easily distinguishable.

Conclusion: The results of this study suggest that Optovue high-resolution OCT is a user-friendly, reproducible modality for measuring scleral thickness. The values obtained with the Optovue OCT were consistent with previously reported values determined by ultrasound pachymetry, light microscopy and ultrasound biomicroscopy.

Keywords: Imaging; OCT; optical coherence tomography; scleral thickness.

22 INTRODUCTION

23 Optical coherence tomography (OCT) is a noncontact, noninvasive, high-speed, high-resolution imaging
 24 modality that has been used to image the retina and the optic nerve [1-6]. Anterior segment OCT uses a
 25 longer wavelength (1310 nm) than the older retinal OCT (820 nm). This allows for greater penetration
 26 through the sclera and the limbus (2 tissues that can highly scatter light) [2]. As such, anterior segment
 27 OCT can acquire and analyze cross sections of the cornea, anterior chamber, iris and the central portion
 28 of the lens [5]. Anterior segment OCT has been used to assess corneal and laser-assisted *in situ*
 29 keratomileusis (LASIK) flap thickness, anatomic outcomes of Descemet stripping automated endothelial
 30 keratoplasty (DSAEK), trabeculectomy morphology, anterior chamber angle anatomy and clear corneal
 31 incisions [5-17]. To our knowledge, there is only 1 other study that has used anterior segment OCT to
 32 image the anterior sclera 3 mm from the limbus [1]. That study used the Visante OCT and obtained
 33 scleral thickness values that were not consistent with those obtained with ultrasound biomicroscopy,
 34 light microscopy or ultrasound pachymetry. This aim of the present study was to assess the Optovue
 35 OCT for anterior segment OCT to measure scleral thickness.

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37 METHODS

38 A prospective, single-center study of patients was performed. Repeated measurements of scleral
 39 thickness were performed with the Optovue OCT using a line scan 3 mm from the limbus in the inferior
 40 nasal and inferior temporal quadrants of each eye. The location of the scan was marked with a marking
 41 pen after making an impression on the sclera with the hub of a tuberculin syringe. The Optovue line scan
 42 was directed toward the center of the pupil for consistency. Obtained values were analyzed with regard
 43 to precision and reproducibility. Correlations to anatomic structures were made. Statistical analysis was
 44 performed with the use of Microsoft Excel functions for descriptive statistics. All applicable institutional

45 and governmental regulations concerning the ethical use of human volunteers were followed during this
46 research.

47

48 RESULTS

49 A total of 27 eyes in 16 patients were assessed (Table 1).

50 **Table 1. Thickness of sclera 3 mm from the limbus**

Patient	Sex	Age, Years	Race	Scleral Thickness (Microns)	Eye
1	Unknown	Unknown		725	OD
				697	OD
				669	OD
				725	OD
				697	OD
				669	OD
2	Unknown	Unknown		725	OS
				697	OS
				669	OS
				688	OS
				614	OS
				679	OS
3	Female	78	White	660	OD
				778	OD
4	Male	85	White	542	OS
				598	OS
5	Female	47	White	559	OS
				685	OS
				654	OS
				589	OS
6	Female	57	White	465	OD
				610	OD
				556	OD
				552	OS
				572	OS
				599	OS
7	Male	25	Hispanic	601	OD
				542	OS
				586	OS
				648	OS
8	Female	20	White	621	OD
				633	OD
				762	OS
				778	OS
9	Female	63	White	658	OD
				617	OD
				660	OD

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				580	OD
				598	OS
				626	OS
				607	OS
				598	OS
10	Female	62	White	703	OD
				695	OD
				670	OD
				607	OD
				679	OD
				648	OD
				635	OS
				654	OS
				679	OS
				647	OS
				653	OS
11	Male	30	Hispanic	664	OD
				620	OD
				611	OD
				614	OD
				604	OD
				617	OS
				648	OS
				648	OS
12	Female	34	White	706	OD
				645	OD
				682	OD
				682	OS
				666	OS
				643	OS
				624	OS
13	Female	64	White	553	OD
				517	OD
				632	OD
				673	OS
				670	OS
				638	OS
14	Female	64	White	651	OD
				666	OD
				651	OD
				785	OS
15	Male	62	White	840	OD
				749	OD
				858	OD
				790	OS
				766	OS
				831	OS
16	Male	57	White	791	OD
				772	OD
				791	OD

				756	OS
				807	OS
				727	OS

An average of 3 measurements per location per eye were obtained. The mean scleral thickness 3 mm from the limbus was 662 microns. The mean standard deviation of the measurements from each location was 54 microns. The boundary of the conjunctiva and sclera was easily distinguishable (Fig. 1). The data recorded were from the eyes with clear anatomic landmarks.

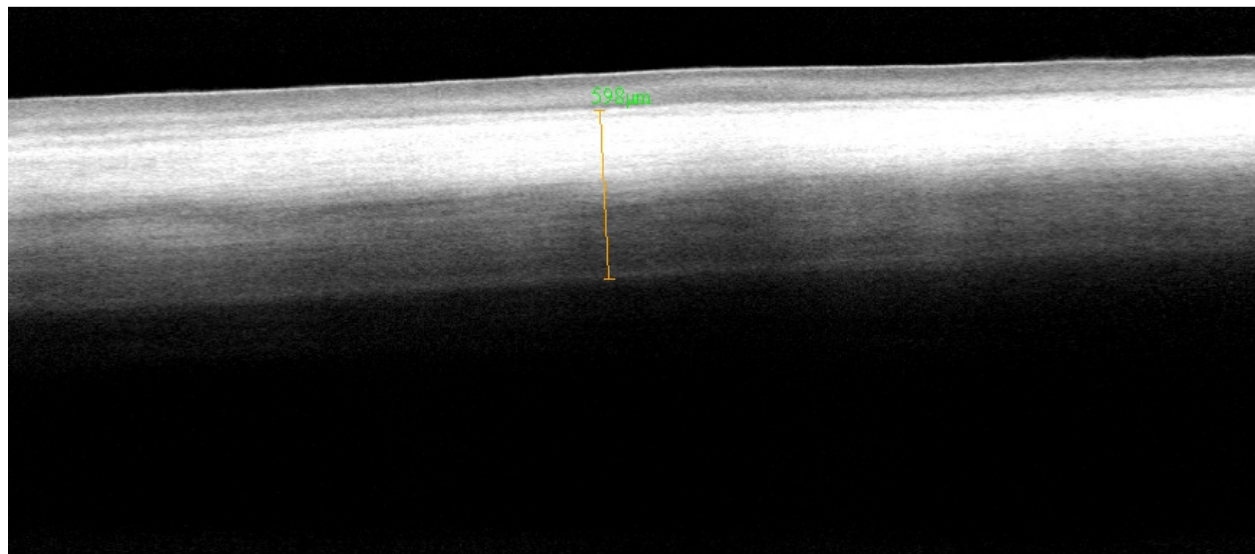


Figure 1. Images of sclera 3 mm from the limbus with Optovue OCT. We propose that the boundary between the conjunctiva and sclera is as is marked by the calipers.

DISCUSSION

Although anterior segment OCT has been used to image many different aspects of the eye, there are few studies in which it has been used to image the sclera. The study by Taban and colleagues assessed scleral thickness with the Visante OCT in patients who had received fluocinolone acetonide implants [1]. That study yielded results that were precise but not consistent with those of other imaging modalities of scleral thickness at that particular location; their results showed an average scleral thickness of 918

microns 3.5 mm from the limbus [1]. Previous studies using ultrasound pachymetry measured that same location to be 470 microns thick; light microscopy measured 509 microns; and ultrasound biomicroscopy measured 550 microns 3 mm from the scleral spur [1]. The large difference between previously studied modalities and the study using Visante OCT spurred us to look for another anterior segment OCT device that might have better anatomic resolution and which would give us more consistent data.

The results of the present study suggest that Optovue high-resolution OCT is a useful modality for measuring scleral thickness. It is a noncontact, user-friendly mode of imaging that does not require the photographer expertise or imaging expense of other methods such as ultrasound biomicroscopy. Average scleral thickness was 662 microns with the Optovue OCT, which was 256 microns thinner than the value reported with the Visante OCT [1], and much more consistent with previously reported values as determined by ultrasound pachymetry, light microscopy and ultrasound biomicroscopy. We hypothesize that the difference is due to a greater clarity of demarcation between anatomic structures with the Optovue OCT. A proposed anatomic distinction between the conjunctiva and the sclera was identified with Optovue OCT in images; this was not discerned in the Visante images. This would be expected to lead to more accurate measurements of scleral thickness.

Future directions for this imaging method include population-based studies to determine average scleral thickness in different age groups and ethnicities and between sexes. It could also be used to quantify progressive scleral thinning after intravitreal injections, pars plana implants, or other therapy delivered through the anterior sclera.

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