Choroidal thickness changes following cataract surgery using swept source optical coherence tomography

Rida Shahzad, MBBS,[*] M.A. Rehman Siddiqui, FRCOphth, FRCSEd,[†,‡,§] Sidra Zafar, MBBS,[*] Farzana Kausar, BS Ophthalmology,[†,‖] Masroor H. Shahzad, FRCOphth[†]

ABSTRACT •

Objective: The aim of this study was to assess changes in subfoveal choroidal thickness (SFCT), measured using swept-source optical coherence tomography (SS-OCT), after routine phacoemulsification cataract surgery.

Design: This is a prospective, interventional, controlled study that took place at Shahzad Eye Hospital, Karachi, Pakistan, between February 2015 and January 2016.

Participants: One hundred and one patients who were undergoing routine cataract surgery were recruited. One eye per patient was included. The unoperated fellow eyes acted as controls.

Methods: Swept-source optical coherence tomography scans were performed preoperatively, 1 week postoperatively, and 1 month postoperatively. Two independent graders evaluated the scans to measure the SFCT. The SFCT was measured and recorded for OCT scans from each visit. The general linear model repeated analysis technique was used to assess data from the 3 different time intervals, and paired *t* tests were used to assess a statistically significant difference between mean preoperative and postoperative SFCT. Probability values of less than 0.05 were considered to be statistically significant.

Results: The mean preoperative SFCT in the study eye was 272.9 ± 96.2; SFCT was 278.9 ± 101.4 ($p = 0.051$) and 281.5 ± 105.2 ($p = 0.01$) at week 1 and month 1, respectively. In the control eyes, the mean measurement of preoperative SFCT was 274.2 ± 98.5; measurements were 273.8 ± 100.7 ($p = 0.875$) and 277.9 ± 103.1 ($p = 0.063$) at week 1 and month 1, respectively.

Conclusions: There was a gradual increase in SFCT at 1 month after cataract removal in the study eyes. The effect was more pronounced in younger individuals and nondiabetic individuals.

Optical coherence tomography (OCT) allows noninvasive and reliable measurement of retinal and choroidal thickness. Swept-source OCT (SS-OCT) technology is a recent upgrade in OCT technology. SS-OCT uses a 1050-nm laser beam that penetrates the retinal pigment epithelium (RPE) to allow reliable and consistent measurement of choroidal thickness in all B-scans. The laser wavelength is considerably higher than the conventional 850-nm wavelength used in spectral-domain OCT (SD-OCT). In SD-OCT, detection of choroid is often difficult due to light scattering by the RPE. Additionally, the 1050-nm wavelength of SS-OCT penetrates better through media opacities such as vitreous hemorrhage, asteroid hyalosis, and cataracts.

Choroid plays an important role in delivering nutrients and oxygen to the retina and in the regulation of ocular metabolism and temperature. Changes in choroidal thickness have been associated with various ocular pathologies, such as macular degeneration, diabetic retinopathy, and central serous chorioretinopathy.[1,2] In addition to diseases, ocular surgeries such as vitrectomy, scleral buckling, myopic excimer laser surgery, and trabeculectomy cause changes in the thickness of choroid.[3–6] However, the data on the change in choroidal thickness after phacoemulsifcation cataract surgery are not clear. Some studies have reported an increase,[7] whereas others have reported no change in choroidal thickness.[8] However, these studies used SD-OCT technology. As far as we know, SS-OCT has not been used to assess choroidal thickness changes after cataract surgery.

The aim of our study was to evaluate changes in subfoveal choroidal thickness (SFCT) after routine phacoemulsification cataract surgery using SS-OCT technology.

Materials and Methods

This is a prospective, interventional, controlled study conducted at Shahzad Eye Hospital, Karachi, Pakistan, between February 2015 and January 2016. The ethics committee of the hospital approved the study, and the participants gave written informed consent. The study adhered to the tenants of the Declaration of Helsinki.

All participants had visually significant cataract in the study eye. Participants with macular diseases, including diabetic maculopathy, severe nonproliferative diabetic retinopathy, central serous chorioretinopathy, and age-related macular degeneration, were excluded from the study. Participants who were unable to return for follow-up visits were also excluded. Each participant underwent full ophthalmic examination, including visual acuity, slit-lamp biomicroscopy, Goldmann applanation tonometry, and dilated fundoscopy, by an experienced

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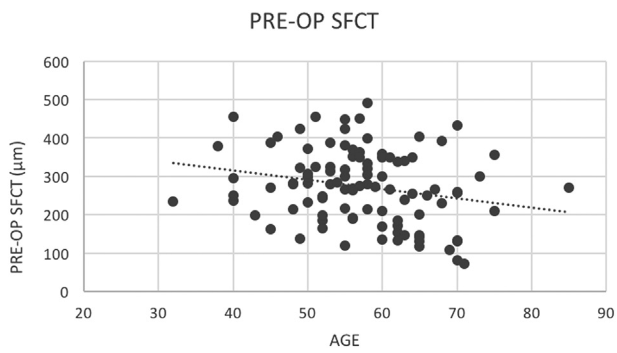

Fig. 1—Scatterplot showing mean subfoveal choroidal thickness (SFCT) vs age preoperatively.

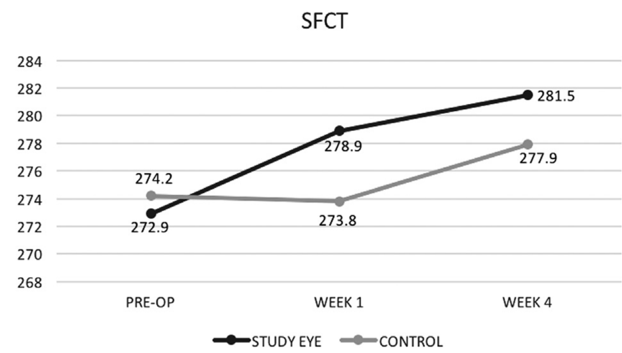

Fig. 2—Changes in subfoveal choroidal thickness (SFCT) before and after surgery. All values in µm.

ophthalmologist. A sample size of 100 participants was the goal for statistical analysis.

An SS-OCT machine (wavelength, 1050 nm; speed, 100 000 A-scans/second; Triton, Topcon Inc, Tokyo, Japan) was used to acquire OCT scans. Trained operators performed all the scans by following a fixed protocol that included dilation of the pupils. We obtained horizontal single-line scans for manual measurement of choroidal thickness. The single-"line" protocol averages 96 B-scans and generates a 12-mm line scan.

Each scan was performed during a fixed time range (2 PM to 6 PM) to minimize the effects of diurnal variation on choroidal thickness.[9] Scans with a poor quality score were repeated. Participants underwent scans of both eyes; the unoperated fellow eyes served as controls. A standard phacoemulsification cataract surgery was performed through a 2.2 mm incision with Centurion Vision System (Alcon Laboratories, Inc, Fort Worth, Tex.). A foldable intraocular lens was implanted as standard. Postoperative drops included moxifloxacin and dexamethasone. OCT scans were performed preoperatively, 1 week postoperatively, and 1 month postoperatively.

SFCT measurements were acquired by the in-built caliper tool of the integrated SS-OCT software (IMAGEnet R4). Manual choroidal thickness was defined as the perpendicular distance from the lower border of the RPE-Bruch's membrane complex to the choroid–scleral junction, measured subfoveally. Two experienced independent graders acquired the measurements. Three readings were taken by each grader at different timings. Each set of readings by the 2 graders was averaged and recorded.

The data were statistically analyzed using SPSS version 19. Intraclass correlation coefficients (ICCs) with 95% confidence intervals were used to determine intragrader and intergrader reliability. The general linear model repeated analysis technique was used to assess data from 3 different time intervals, and mean differences in choroidal thickness pre- and postoperatively (week 1 and month 1) were further analyzed using paired t tests. A p-value of <0.05 was considered statistically significant.

Results

Of the 129 eligible patients, 25 did not complete one of the follow-up visits. Three patients were excluded due to presence of hard cataract that did not allow good-quality SS-OCT images. Two hundred and two eyes from 101 participants were included in the analysis. The mean age of the study participants was 57.5 ± 9.3 years. There were 38 male participants. Mean preoperative vision was 0.57 ± 0.3 (in logMAR), and the mean postoperative vision was 0.13 ± 0.18. The preoperative SFCT of all participants showed an inverse relationship with age (Fig. 1).

Table 1 and Figure 2 show the mean and standard deviation of SFCT of both the study and control groups. Repeated measure analysis was used to evaluate the impact of cataract surgery on SFCT at 3 different time intervals. At 1 month, the choroidal thickness was significantly greater than the preoperative values ($p = 0.01$) in study eyes. Tables 2 and 3 show the changes in SFCT in participants under and over the age of 50 years, which are presented graphically in Figure 3. Similarly, Tables 4 and 5 show SFCT changes in participants with and without

Table 1—Mean ± standard deviation SFCT (µm) of the study and control eyes (n = 101) preoperatively and at week 1 and month 1 visits

Group	Preoperative	Week 1	Month 1	*p*-value (1)	*p*-value (2)
Study eye	272.9 ± 96.2	278.9 ± 101.4	281.5 ± 105.2	0.051	0.01
Control	274.5 ± 98.5	273.8 ± 100.7	277.9 ± 103.1	0.085	0.063

SFCT, subfoveal choroidal thickness.
p-value (1) compares preoperative with week 1. *p*-value (2) compares preoperative with month 1. $p < 0.05$ was considered significant using the paired t test.

Table 2—Mean ± standard deviation SFCT (µm) of the study eyes and controls of patients over 50 years of age (n = 79) at preoperative, week 1, and month 1 visits

Group	Preoperative	Week 1	Month 1	*p*-value (1)	*p*-value (2)
Study eye	268.4 ± 98.2	275.1 ± 104.7	276.4 ± 105.6	0.09	0.06
Control	272.7 ± 100.5	272.9 ± 102.2	277.5 ± 105	0.8	0.2

SFCT, subfoveal choroidal thickness.
p-value (1) compares preoperative with week 1. *p*-value (2) compares preoperative with month 1. $p < 0.05$ was considered significant using the paired t test.

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