Changes in choroidal thickness after cataract surgery

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PURPOSE: To evaluate changes in choroidal thickness before and after cataract surgery and factors affecting the changes.

SETTING: Tsukazaki Hospital, Himeji, Japan.

DESIGN: Prospective interventional study.

METHODS: Patients having cataract surgery without other eye pathology were studied. The corrected distance visual acuity (CDVA), intraocular pressure (IOP), axial length (AL), and enhanced-depth-imaging optical coherence tomography (OCT) were measured preoperatively. The choroidal thickness was measured at 5 points (subfoveal and 1.5 mm nasal, temporal, superior, and inferior to the fovea) using the OCT device's software. Enhanced-depth-imaging OCT and IOP measurements were obtained 3 days, 1 and 3 weeks, and 3 and 6 months postoperatively and compared with the baseline values. Stepwise analysis determined which factors (ie, age, CDVA, preoperative IOP, AL, operative time, changes in IOP) were associated with changes in choroidal thickness.

RESULTS: One hundred eyes were analyzed. The postoperative IOP significantly decreased at 3 weeks, 3 months, and 6 months. The postoperative choroidal thickness significantly increased at the foveal and inferior regions throughout the follow-up; at the nasal region at 3 days, 1 week, and 6 months; at the temporal region at 1 week; and at the superior region at 6 months. These changes negatively correlated with those in IOP early after surgery. The changes in choroidal thickness later negatively correlated with the AL in all regions.

CONCLUSION: Cataract surgery caused changes in choroidal thickness. The AL and changes in the IOP are critical for evaluating the changes in choroidal thickness.

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The choroid, a highly vascularized structure located between the lamina fusca of the sclera and the retinal pigment epithelium (RPE), is an important tissue that supplies blood to the outer retina and is the source of many vision-threatening diseases, such as choroidal neovascularization,[1] polypoidal choroidal vasculopathy,[2,3] central serous chorioretinopathy,[4–6] and high myopia–related chorioretinal atrophy.[7–9] Therefore, studying the choroidal structures is important for understanding the pathology and mechanisms underlying these critical diseases.

Spectral-domain optical coherence tomography (OCT) is a noninvasive noncontact transpupillary imaging modality used to diagnose, make treatment decisions, and monitor many retinal diseases.[10,11] Similarly, obtaining choroidal thickness measurements is useful for evaluating choroidal thickening and thinning diseases. However, spectral-domain OCT has a limited ability to image the choroid due to scattering caused by the pigments in the RPE and choroidal vessels and a depth-dependent roll-off in sensitivity. A new method for visualizing the choroid, enhanced-depth-imaging OCT, has been reported.[12] Enhanced-depth-imaging is an innovation of post-processing that uses a commercially available spectral-domain OCT device. Deep choroidal images are enhanced by taking inverted images and using multiple B-scan averaging to improve the signal-to-noise ratio (SNR). Choroidal thickness is reported to be significantly related to specific pathologies. For

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instance, the choroid is thicker in eyes with central serous chorioretinopathy than in normal eyes,[13,14] and the choroid is thinner in patients with a myopic shift or axial length (AL) elongation.[15–17] Choroidal thinning also is more prominent in highly myopic eyes with choroidal neovascularization.[16,18] Therefore, choroidal thickness is being measured increasingly more often and is becoming an accepted procedure for clinical and research applications.

On the other hand, cataract is a major cause of visual impairment in the elderly. Cataract surgery is the most common ophthalmic surgery and is performed simultaneously with glaucoma or vitreous surgery in many cases. However, according to the results in epidemiology studies, cataract surgery is associated with the onset of age-related macular degeneration (AMD).[19–21] This process may be mediated via inflammatory reactions associated with the surgery,[22,23] postoperative biochemical environmental changes in the eye (increased free radicals or growth factors),[22,24,25] and/or increased light exposure during or after surgery.[26,27] Age-related macular degeneration is a serious disease that results in central visual impairment due to neovascularization originating from the choroid. It is possible that some changes occur in the choroid as a result of cataract surgery and that they affect the development of AMD. Pierru et al.[A] report that cataract surgery increased the subfoveal choroidal thickness; however, to our knowledge, there have been no full-length articles reporting such changes. In this study, we evaluated changes in choroidal thickness before and after cataract surgery and assessed factors that affect these changes.

PATIENTS AND METHODS

This prospective clinical study comprised consecutive patients with no systemic disease or other ophthalmic disease who had cataract surgery at Tsukazaki Hospital between November 20, 2010, and March 31, 2011. The research adhered to the Declaration of Helsinki, and the study was approved by the Ethics Committee, Tsukazaki Hospital. All patients provided written informed consent before the initiation of the study.

The exclusion criteria were a history of intraocular surgery, retinal pathology, choroidal pathology, glaucoma, or systemic disease such as diabetes mellitus or hypertension and/or poor OCT images due to severe cataracts or unstable fixation. The exclusion criteria after cataract surgery included the development of glaucoma or cystoid macular edema, which can affect or be affected by the underlying choroidal changes.

The patients were screened to meet the following inclusion criteria: cataracts with a spherical equivalent (SE) refractive error between −3.00 diopters (D) and +3.00 D, no posterior abnormalities, and clear spectral-domain OCT data using the Spectralis device (Heidelberg Engineering GmbH). This device can be used to automatically place follow-up scans in precisely the same locations.

Patient Assessment

The patients had detailed ocular examinations, including assessments with an autokeratorefractometer (KR-8800, Topcon Corp.), slitlamp evaluation, dilated fundoscopy, and measurements of the corrected distance visual acuity (CDVA), intraocular pressure (IOP) (CT90A, Topcon Corp.), and AL using an interferometer (IOLMaster, Carl Zeiss Meditec AG).

Measurements of OCT, AL, and IOP were obtained 1 week before cataract surgery. Optical coherence tomography and IOP measurements were also obtained 3 days, 1 and 3 weeks, and 3 and 6 months after cataract surgery. To avoid the effects of mydriatic agents or diurnal changes,[28] all measurements were obtained under nonmydriatic conditions between 9 AM and 12 PM.

Surgical Technique

Eyes were prepared for surgery by instilling tropicamide–phenylephrine hydrochloride 0.5% for pupil dilation and oxybuprocaine hydrochloride 0.4% for topical anesthesia. Balloon compression, which may compress the choroid and thin it, was not used. All surgeries were performed by experienced surgeons (H.O., Z.O., H.I., S.N., S.M., Y.K., H.T.) using the same technique that comprised phacoemulsification with a 2.8 mm clear corneal incision, a vacuum of 280 mm Hg, an aspiration flow rate of 40 mL/min, and a bottle height of 75 cm. The operative time was recorded in each case.

Postoperatively, all patients were treated with levofloxacin hydrate 1.5% and fluorometholone 0.1% 4 times daily for 2 weeks. This was followed by nepafenac 0.1% 3 times daily for an additional 3 weeks.

Enhanced-Depth-Imaging Optical Coherence Tomography

The enhanced-depth-imaging OCT device was operated by the same experienced technician. The choroid was imaged using the device with eye tracking and image-averaging systems, as previously described.[12] The OCT device was pushed sufficiently close to the eye to obtain an inverted image. Each section was imaged using eye tracking, and 100 B-scans were

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