American Journal of Ophthalmology Case Reports 3 (2016) 54–60

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: http://www.ajocasereports.com/

Brief report

Morphological changes after trabeculectomy in highly myopic eyes with high intraocular pressure by using swept-source optical coherence tomography

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ARTICLE INFO

Article history:
Received 5 April 2016
Received in revised form
4 June 2016
Accepted 27 June 2016
Available online 29 June 2016

Keywords:
High myopia
Trabeculectomy
Intraocular pressure
Scleral deformation
Posterior staphyloma

ABSTRACT

Purpose: To investigate the effects of intraocular pressure (IOP) reduction on the eyeball shape in highly myopic eyes with high IOP.
Methods: This study included patients with an axial length ≥26.5 mm and high IOP ≥22 mmHg after receiving maximum medication, with successful trabeculectomy by a single surgeon, and who underwent swept-source optical coherence tomography (SS-OCT) examinations on preoperative and postoperative ≥3 months periods. Eight eyes of 7 patients were included in the analysis. The morphological changes in the eyeball that occurred pre- and post-operation were analyzed from the SS-OCT images.
Results: In 6 out of 8 examined eyes, the following apparent morphological changes in the posterior pole and/or peripapillary sclera were postoperatively detected on SS-OCT images: peripapillary scleral shrinkage, decrease in the lamina cribrosa depth, flattening of the peripapillary scleral insertion into the optic disc, decrease in the angle of the scleral protrusion temporal to the optic disc, and inhomogeneous change in scleral curvature of the posterior pole.
Conclusions and importance: We found that the shape of some eyes with high myopia and high IOP changed owing to the decrease in IOP. Eyeball deformities may be affected by high IOP, and IOP reduction might reduce scleral deformation in highly myopic eyes with high IOP.

1. Introduction

In highly myopic eyes, the optic disc and eyeball shape are often deformed [1,2]. In pathologic myopia, defects in the visual field that are not associated with chorioretinal lesions or no detectable cause are frequently observed [3]. We reported that a subset of high myopic eyes may be affected by direct scleral compression or stretching at the peripapillary scleral protrusion [2]. Although it is sometimes difficult to determine whether the visual field defects are caused by glaucoma or pathologic myopia, it is generally accepted that controlling intraocular pressure (IOP) is important in eyes with visual field defects and high IOP. IOP reduction could have various effects on papillary and/or peripapillary structures. In young patients, it has been reported that IOP reduction could induce an increase in the neuroretinal rim area, decrease or increase parapapillary atrophy, and/or cause disc shape changes [4,5]. In adults, IOP reduction leads to a decrease in the size and depth of the disc cup, peripapillary retinal nerve fiber layer (RNFL) thickness, lamina cribrosa (LC) depth, axial length reduction, and increase in choroidal thickness [6–11]. However, it has not been well elucidated how IOP reduction affects the structure of the highly myopic eyes.

In the present study, we investigated the morphology of the posterior pole and peripapillary sclera before and after IOP reduction by trabeculectomy in highly myopic eyes with high IOP. The morphology was examined using swept-source optical coherence tomography (SS-OCT), and some cases showed drastic

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http://dx.doi.org/10.1016/j.ajoc.2016.06.006

Table 1
Details of each eye included in the study.

Case no./ sex/age (y)	Side	Operation date	Preoperative examination						Postoperative examination						Changes in the eyeball shape after surgery
			IOP (mmHg)	BCVA	Medication score	Axial length (mm)	Refractive error (D)	CCT (μm)	Time-period after surgery (months)	IOP (mmHg)	BCVA	Medication score	Axial length (mm)	Refractive error (D)	
1/F/71	R	Sep 2011	28	20/40	3	29.07	−3.25 (IOL)	508	29	14	20/50	1	28.59	−3.5	**Slight**
2/F/41	R	Sep 2011	32	20/32	4	26.54	−6.0	n/a	9	17	20/50	1	26.47	−6.0	Not obvious
3/F/90	R	Feb 2012	40	20/200	5	26.51	−2.75 (IOL)	512	7	11	20/200	0	26.29	−2.75	**Slight**
4/M/65	R	Jun 2014	23	20/25	4	28.45	−6.75	565	14	16	20/25	3	28.27	−6.75	Not obvious
5/M/73	R	Dec 2014	30	20/16	4	33.41	−6.0 (IOL)	510	10	7	20/16	0	33.29	−5.0	**Obvious**
	L	Dec 2014	23	20/16	5	33.51	−5.75 (IOL)	514	10	5	20/20	0	33.29	−4.5	**Obvious**
6/M/30	L	Jan 2015	40	20/320	4	33.60	−23.0	597	10	9	20/250	0	29.47	−15.5	**Obvious**
7/M/46	R	Mar 2015	24	20/63	4	28.26	−8.0	488	8	9	20/50	0	27.98	−8.75	**Slight**

R, right; L, left; BCVA, best-corrected visual acuity; CCT, central corneal thickness; IOP, intraocular pressure; IOL, intraocular lens; n/a, not applicable.

morphological changes in eyeball shape as a response to IOP reduction.

2. Materials and methods

2.1. Patients

This retrospective observational case series study adhered to the tenets of the Declaration of Helsinki. A review of the medical records was approved by the Institutional Review Board and Ethics Committee of the Kyoto University Graduate School of Medicine. The medical records of patients who had undergone trabeculectomy at the Kyoto University Hospital between January 1, 2011, and March 31, 2015 by one surgeon (TA) were reviewed. Trabeculectomy with mitomycin-C was performed by making a fornix-based conjunctival incision and a 3.0 × 3.0-mm quadrangular scleral flap. The inclusion criteria were: normal anterior segment, normal and open angle by gonioscopy, axial length ≥26.5 mm, preoperative IOP ≥22 mmHg with maximum tolerable medication, and preoperative and ≥3 months postoperative SS-OCT examinations. The exclusion criteria were hazy media, systemic disease, and IOP ≥22 mmHg on postoperative SS-OCT examination. Patients with evidence of vitreoretinal disease associated with high myopia (e.g.,posterior staphyloma, chorioretinal atrophy, and myopic choroidal neovascularization) were not excluded.

2.2. Swept-source optical coherence tomography examination

SS-OCT examination using DRI OCT-1 (Topcon, Tokyo, Japan) [2,12], IOP measurement by Goldmann applanation tonometry, axial length measurement (IOLMaster 500, Carl Zeiss Meditec, Dublin, CA), and fundus photography were performed on the same day pre and postoperatively. Postoperative SS-OCT images with a 12-mm line were repeatedly obtained to gain the images scanned at the same location as the preoperative images. We carefully identified whether the locations of the pre and postoperative scan images were the same with reference to scanning laser ophthalmoscopy images acquired simultaneously, and the images at almost the same location were used for the analysis.

3. Results

3.1. Patients

This study initially involved 12 eyes of 10 participants. Finally, 8 eyes of 7 participants were evaluated before and after trabeculectomy. Eyes with secondary glaucoma, such as pseudoexfoliation, uveitis, or neovascular glaucoma, were not included in this study. No additional operation was performed and no major complication was found during the follow-up period in all cases. The pre and postoperative details of the eyes are shown in Table 1.

3.2. Swept-source optical coherence tomography imaging evaluation

Only 1 eye showed apparent morphological change on fundus photography (case 6). Obvious or slight morphological changes in the posterior and/or peripapillary sclera were postoperatively detected on SS-OCT images in 6 eyes (obvious changes, cases 5R, 5L, and 6, Figs. 1–3; slight change, cases 1, 3, and 7, Fig. 4). The morphological changes in the shape of the eyeball included several types of changes. The peripapillary sclera had shrunk and shortened postoperatively, and the LC depth was eventually reduced (cases 5R, 5L, and 7). The angle between the sclera inserting into the optic disc and that at the opposite side became more flattened in the vertical OCT B-scan (cases 1 and 5L). The angle of the scleral protrusion temporal to the optic disc decreased in size postoperatively (cases 5L and 7). The scleral curvatures of the posterior pole were apparently changed after the operation (cases 3, 5L, and 6). In case 6, the shape of the posterior staphyloma heterogeneously changed after the operation. The inferior area, where the posterior staphyloma was apparent before the operation, had moved ahead after the operation (Fig. 3). It should be noted that the postoperative IOP was 9 mmHg, which did not indicate hypotony. No apparent morphological change in the posterior or peripapillary sclera was detected between pre and postoperative periods in 2 eyes (cases 2 and 4).