Central scotoma after indocyanine green assisted fovea-sparing internal limiting membrane peeling

Tsuyoshi Mito a, b, *, Takeshi Kobayashi a, Atsushi Shiraiishi a

a Department of Ophthalmology, University of Ehime Graduate School of Medicine, Japan
b Department of Ophthalmology, Kanazawa Medical University, Japan

1. Introduction

In 2004, Panozzo et al. proposed the name myopic traction maculopathy (MTM) to unify the macular abnormalities, such as foveal retinoschisis, lamellar holes, and foveal detachment, that are caused by vitreous traction in highly myopic eyes. To prevent a progression of the lesions associated with MTM, vitrectomy is performed to remove the traction on the retina by an epiretinal membrane (ERM), posterior vitreous cortex, or internal limiting membrane (ILM). However, there is a risk of intraoperative and postoperative macular hole (MH) formation from the foveal detachments in these eyes with MTM.

Recently, Shimada et al. described a fovea-sparing ILM peeling technique to treat eyes with MTM, and they reported good visual and anatomic outcomes without MH formation. To accomplish a complete ILM peeling, a dyeing agent such as indocyanine green (ICG) or Brilliant Blue G (BBG) is used to make the ILM more visible. ICG has been reportedly to be superior to BBG in making the ILM visible; however there has been some concern that it may be toxic. Nevertheless, some surgeons are still using ICG staining in patients with high myopia in which the ILM is difficult to detect.

We present our findings in an eye with MTM that underwent fovea-sparing ILM peeling with ICG staining and developed a postoperative central scotoma and a constriction of the nasal visual field.

1.1. Case report

A 63-year-old man was being followed at a local ophthalmic clinic for bilateral MTM since 2011, and his best-corrected visual acuity (BCVA) was 20/20 in both eyes for several years. However, the BCVA of his right eye gradually worsened in the past few years, and it was 20/80 in 2018. He was then referred to the Ehime University Hospital.

At his initial examination, optical coherence tomography (OCT) revealed a foveal retinoschisis and a small outer lamellar macular hole beneath a focally-thickened area in the right eye (Fig. 1). He underwent 25-gauge 3-port pars plana vitrectomy and fovea-sparing ILM peeling using indocyanine green (ICG) staining.

One year after the vitrectomy, optical coherence tomography (OCT) revealed a resolution of the macular retinoschisis and an intact ellipsoid zone at the fovea. However, macular edema was present over the area of the residual ILM, and the visual acuity had worsened to 20/200. Goldmann perimetry showed a central scotoma and a constriction of the nasal visual field. OCT angiography detected abnormal blood flow in the inner retina corresponding to the area of the residual foveal ILM. The multifocal electrotoretinograms were reduced in the central area.

The findings suggest that functional abnormalities of the fovea induced by ICG toxicity may have been manifested by a central scotoma. Therefore, surgeons need to consider the toxic effects of dyes such as ICG.
it out. However, we needed to repeat the ICG staining three times during the ILM removal to make ILM more visible. The ILM was peeled from the macular area except over the foveal area. The size of the residual ILM was about one-disc diameter (Fig. 2 A–D).

One year later, OCT examinations revealed a resolution of the macular retinoschisis, and an intact ellipsoid zone at the fovea. However, the macular area was edematous especially the inner nuclear layer and outer plexiform layer (Fig. 3 A), and the BCVA had worsened to 20/200. Goldmann perimetry showed a central scotoma and constriction of the nasal visual field of the right eye (Fig. 4). OCT angiography detected abnormal blood flow, and the en face images had a cystoid pattern in the deep retinal plexus corresponding to the area of the residual foveal ILM (Fig. 3 B). The multifocal electroretinograms (mERGs) were reduced in the central retina of the right eye, and they were smaller than that of the left eye (Fig. 5 A and B).

2. Discussion

Fovea-sparing ILM peeling is an important procedure that can prevent MH formation in eyes with MTM. Our patient obtained good postoperative macular morphology without a MH, however his BCVA worsened and a constriction of the nasal visual field was present postoperatively.

Earlier studies have reported that visual field defects can develop after vitrectomy, and it has been suggested that retinal contusion from the high airflow from the infusion port during fluid-air exchange was the cause of the temporal visual field defects.\textsuperscript{10,11} However, we did not perform fluid-air exchange, and did not observe a rise in the postoperative intraocular pressure that might have caused the visual field abnormalities. In addition, the morphology of the optic disc was not changed after the vitrectomy, and the results of tests for a relative afferent pupillary defect was negative. The reduction in the amplitudes of the mERGs in the central regions suggests that the central scotoma was not associated with glaucoma which results of damage of only the retinal nerve fiber layer and ganglion cell layer.

Alterations of the physiology of the retina by ILM peeling is another possible reason for the visual field defects, but it is unlikely in this case because the ILM over the foveal area was not peeled.

There have been two studies that reported ICG toxicity may be the cause of the visual field defects after vitrectomy.\textsuperscript{12,13} Most of the cases reported had nasal visual field defects, but the authors did not definitively determine the cause of the visual field defects. There is a possibility that part of the ICG dye had remained on the temporal retina while the ICG on the nasal retina was washed out because of the location of the perfusion port.

The central scotoma in our cases was located where the ILM...
remained on the fovea. We suggest that the remaining ILM stained with ICG might be related to the central scotoma. Tognetto et al. reported a case of ICG-related central visual field disorder and observed an extensive, diffuse whitening and thickening of the macular region on the day after the vitrectomy for ERM removal using 0.05% ICG for ILM staining. They suggested that the ICG might have come into contact with the ILM-free retina and penetrated into the deeper retinal layers. However, the ILM was not peeled off the macular region in our case, and we did not observe a retinal whitening or intense macular edema in the early period after the vitrectomy.

There are at least two possible reasons why the central scotoma developed in our case. First, ICG staining was performed several times during surgery because it was difficult to see the ILM in the myopic eye. As a result, a relatively higher amount of ICG may have accumulated on the ILM which was not washed out at the completion of the fovea-sparing ILM peeling. Enaida et al. reported that severely deformed retinal structures and a partial disappearance of the retinal pigment epithelium in light photomicrographs of a rat eye after an intravitreal injection of a high-dose of ICG. They reported that the amplitudes of the ERGs were reduced after the intravitreal ICG injection. These morphological and functional alterations of the retina occurred in a dose dependent manner. Second, it is known that ICG is activated by high-power laser lights and by long duration continuous light exposure through optic fibers used for intraocular illumination. It is possible that an enhancement of the ICG toxicity may be another reason because it required more time to manipulate the ILM in the myopic fundus.

3. Conclusions

In summary, we report a case that developed a central scotoma after fovea-sparing ILM peeling with ICG staining of the ILM. Therefore, surgeons need to consider the toxic effects of ICG even though the frequency of adverse complication is not high.
Fig. 4. Postoperative Goldmann visual fields showing central scotoma and nasal visual field defect in the right eye.
Patient consent

Written informed consent was obtained from the patient to publish and report individual patient data.

Funding

No funding was received by any of the authors for writing this manuscript.

Authorship

All authors attest that they meet the current ICMJE criteria for authorship.

Declaration of competing interest

All authors have no financial disclosures.

Acknowledgements

We thank Professor Emeritus Duco Hamasaki of the Bascom Palmer Eye Institute for his critical discussion and final manuscript revision.

References

1. Panizzo G, Mercanti A. Optical coherence tomography findings in myopic traction maculopathy. Arch Ophthalmol. 2004;122(10):1455–1460.
2. Ikuno Y, Sayanagi K, Ohji M, et al. Vitrectomy and internal limiting membrane peeling for myopic foveoschisis. Am J Ophthalmol. 2004;137(4):719–724.
3. Panizzo G, Mercanti A. Vitrectomy for myopic traction maculopathy. Arch Ophthalmol. 2007;125(6):767–772.
4. Kobayashi H, Kishi S. Vitreous surgery for highly myopic eyes with foveal detachment and retinoschisis. Ophthalmology. 2003;110(9):1702–1707.
5. Gaucher D, Haouchine B, Tadayoni R, et al. Long-term follow-up of high myopic foveoschisis: natural course and surgical outcome. Am J Ophthalmol. 2007;143(3):455–462.
6. Shimada N, Sugamoto Y, Ogawa M, Takase H, Ohno-Matsui K. Fovea-sparing internal limiting membrane peeling for myopic traction maculopathy. Am J Ophthalmol. 2012;154(4):693–701.
7. Henrich PB, Priglinger SG, Haritoglou C, et al. Quantification of contrast recognizability during brilliant blue G- and indocyanine green-assisted chromovitrectomy. *Invest Ophthalmol Vis Sci*. 2011;52(7):4345–4349.

8. Kadonosono K, Arakawa A, Inoue M, et al. Internal limiting membrane contrast after staining with indocyanine green and brilliant blue G during macular surgery. *Retina*. 2013;33(4):812–817.

9. Enaida H, Sakamoto T, Hisatomi T, et al. Morphological and functional damage of the retina caused by intravitreal indocyanine green in rat eyes. *Graefes Arch Clin Exp Ophthalmol*. 2002;240(3):209–213.

10. Melberg NS, Thomas MA. Visual field loss after pars plana vitrectomy with air/fluid exchange. *Am J Ophthalmol*. 1995;120(3):386–388.

11. Ohji M, Nao IN, Saito Y, Hayashi A, Tano Y. Prevention of visual field defect after macular hole surgery by passing air used for fluid-air exchange through water. *Am J Ophthalmol*. 1999;127(1):62–66.

12. Haritoglou C, Gandorfer A, Gans CA, Schasberger M, Ulbig MW, Kampik A. The effect of indocyanine-green on functional outcome of macular pucker surgery. *Am J Ophthalmol*. 2005;135(2):328–337.

13. Kanda S, Uemura A, Yamashita T, Kita H, Yamakiri K, Sakamoto T. Visual field defects after intravitreous administration of indocyanine green in macular hole surgery. *Arch Ophthalmol*. 2004;122(10):1447–1451.

14. Tognetto D, Haritoglou C, Kampik A, Ravalico G. Macular edema and visual loss after macular pucker surgery with ICG-assisted internal limiting membrane peeling. *Eur J Ophthalmol*. 2005;15(2):289–291.

15. Sippy BD, Engelbrecht NE, Hubbard GB, et al. Indocyanine green effect on cultured human retinal pigment epithelial cell: implication for macular hole surgery. *Am J Ophthalmol*. 2001;132(3):433–435.