Risk Factors for Development of Full-Thickness Macular Holes After Pars Plana Vitrectomy for Myopic Foveoschisis

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• PURPOSE: **To identify risk factors for development of secondary full-thickness macular holes after pars plana vitrectomy with internal limiting membrane (ILM) peeling for myopic foveoschisis.**

• DESIGN: **Retrospective, interventional case series.**

• METHODS: **We retrospectively reviewed the records of 42 eyes (42 patients) treated with pars plana vitrectomy (vitreous separation, internal limiting membrane peeling, and gas tamponade) for myopic foveoschisis with and without a retinal detachment but without a macular hole from January 2002 through June 2012. Cataract surgery was performed in all phakic eyes. Patients were followed up for 6 months after the initial surgery, and optical coherence tomography images were obtained at every visit. The factors associated with development of postoperative full-thickness macular holes were investigated.**

• RESULTS: **A postoperative macular hole developed in 8 (19.0%) eyes. No significant correlations of age ($P = .369$), axial length ($P = .113$), visual acuity ($P = .859$), foveal status ($P = .331$), posterior staphyloma ($P = 1.000$), or chorioretinal atrophy ($P = .837$) were found between patients with and without secondary macular holes. Among the characteristics seen on the optical coherence tomography images, the percentage of eyes with an inner segment/outer segment junction defect was significantly ($P = .013$, Fisher exact test) higher in patients with a macular hole than in those without a macular hole. Logistic regression analysis showed that only an inner segment/outer segment junction defect ($P = .018$) was a significant risk factor for development of secondary macular holes.**

• CONCLUSIONS: **Secondary macular holes can develop in myopic foveoschisis after pars plana vitrectomy with internal limiting membrane peeling. A preoperative inner segment/outer segment junction defect can be a risk factor for development of a macular hole.** **(Am J Ophthalmol 2013;155:1021–1027. © 2013 by Elsevier Inc. All rights reserved.)**

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MYOPIC FOVEOSCHISIS IS NOT AN UNCOMMON complication of pathologic myopia, with the incidence rates ranging from 9% to 34% in highly myopic eyes with posterior staphyloma.[1–3] The mechanism of myopic foveoschisis formation is unclear, and axial length elongation, posterior staphyloma, vitreoretinal traction, and inflexibility of the retinal vessels are thought to be associated factors.[4–6] Based on the foveal status on optical coherence tomography (OCT) images, eyes with myopic foveoschisis can be divided into 3 types: those with a foveal detachment, retinoschisis, or a macular hole.[7]

Regarding the former 2 types, there is no general consensus about the surgical indications. Pars plana vitrectomy with internal limiting membrane (ILM) peeling is beneficial for treating myopic foveoschisis. Kim and associates retrospectively evaluated the benefits of vitrectomy with ILM peeling in 17 cases of myopic foveoschisis, and the gas-treated group and the group not treated with gas achieved good anatomic and visual outcomes 12 months after the initial vitrectomy.[8] In another study in which 6 eyes with myopic foveoschisis and a foveal detachment underwent vitrectomy with ILM peeling and gas tamponade, the visual acuity (VA) improved more than 2 lines in all eyes and the foveal detachment resolved completely in 83% cases, although the follow-up period was only 6 months.[9] Increasing evidence has indicated that vitrectomy is a safe and effective treatment for myopic foveoschisis.[4,9,10]

However, macular holes can develop after surgery. After they do, they are difficult to treat, and the surgical results usually are less than satisfactory.[11–13] Kobayashi and Kishi studied 9 cases of highly myopic eyes with a foveal detachment and retinoschisis to evaluate the benefits of vitrectomy; the authors detected a microhole in 1 case during vitrectomy. The outcomes indicated that a full-thickness macular hole developed after surgery and the final best-corrected VA (BCVA) was unfavorable.[4]

The factors contributing to the development of postoperative macular holes in highly myopic eyes are not well understood. The purpose of the current study was to determine the possible mechanisms and risk factors for the development of secondary macular holes in myopic foveoschisis based on OCT findings.

METHODS

• **PATIENTS:** The study was performed in accordance with the tenets of the Declaration of Helsinki. The

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Institutional Review Board of the Osaka University Hospital approved the study. All patients provided written informed consent before surgery was performed. The study was a retrospective, consecutive, interventional case series of highly myopic patients who underwent pars plana vitrectomy with ILM peeling for myopic foveoschisis with or without retinal detachment from January 2002 through June 2012 at the Department of Ophthalmology, Osaka University Medical School. The inclusion criteria were a progressive decrease in vision resulting from myopic foveoschisis with an axial length no less than 26 mm and a follow-up period exceeding 6 months after initial pars plana vitrectomy. Eyes were excluded that had a history of pre-existing ocular diseases that can result in development of macular holes such as proliferative vitreoretinopathy. Another exclusion criterion was a previous history of pars plana vitrectomy.

• **DATA COLLECTION:** The following data were collected from the medical records: age, sex, preoperative lens status, refractive error, axial length, preoperative BCVA, OCT findings, and the availability of color fundus photography. Diffuse atrophy was defined as the presence of yellowish-white lesions with an ill-defined border at the posterior fundus; patchy atrophy was defined as the presence of grayish-white, well-defined lesions.[14]

• **SURGICAL PROCEDURE:** One experienced surgeon (Y.I.) performed all vitrectomies. Phacoemulsification and intraocular lens insertion were performed in all phakic eyes with vitrectomy. Conventional 3-port vitrectomy was carried out using a 20-, 23-, or 25-gauge system as previously described.[9] Triamcinolone acetonide (0.2 mL of 20 mg/mL) was injected into the vitreous cavity during surgery to facilitate visualization of the vitreous cortex; the residual vitreous then was removed gently from the surface of the posterior retina with a diamond-dusted membrane scraper. After the vitreous cortex was removed, the ILM was stained with 0.5% indocyanine green (0.2 mL) or 0.025% brilliant blue G; ILM peeling began with pinching of the ILM within a vascular arcade using an end-gripping forceps as far as possible from the fovea. Two to 3 disc diameters of the ILM then were peeled gently using intraocular forceps in a circular fashion. The other retinal layers were not touched during peeling. Maximum care was taken not to stress the retina, especially at the fovea. Finally, a fluid-air exchange was performed followed by gas tamponade using sulfur hexafluoride. No macular holes were detected at the end of surgery. Patients were instructed to maintain a face-down position for at least 3 days after surgery.

• **OPTICAL COHERENCE TOMOGRAPHY:** OCT was performed before and after surgery to observe the retinal microstructures. The presence or absence of postoperative macular holes was evaluated using time-domain OCT (Stratus OCT; Carl Zeiss Meditec, La Jolla, California, USA) or spectral-domain OCT (Cirrus high-definition OCT; Carl Zeiss Meditec). A cross-scan for Stratus OCT and a 5-line raster scan for Cirrus OCT were centered at the fixation point. An independent masked technician performed all the examinations. Two investigators (X.G. and Y.I.) independently evaluated all the OCT images. The images were displayed on a monitor and 1 author (S.F.) showed the images to the raters; the patients' names were masked. The foveal status and microstructural changes in the photoreceptor layer (hyperreflective line corresponding to the inner segment/outer segment (IS/OS) junction, the external limiting membrane, or both) were judged in each image. Any discrepancies were resolved by discussion until a consensus was reached. A defect in the IS/OS junction was defined as disrupted or lacking a reflective line above the retinal pigment epithelium (RPE) within 500 μm of the foveal center. The foveal status was evaluated by the presence of a foveal detachment of the photoreceptor layer from the RPE. A foveal detachment was defined as a detachment of the photoreceptor layer from the RPE seen in any OCT scans at the fovea; myopic foveoschisis without a foveal detachment was characterized by attachment of the photoreceptor layer to the RPE.

• **STATISTICAL ANALYSIS:** Statistical analysis was performed using Sigma Stat software (SPSS Inc, Chicago, Illinois, USA). Descriptive statistics, including the median values, standard deviations (SD), minimum and maximum values, and percentages, were used to describe the baseline characteristics. Differences in the incidence rates of the OCT findings between patients with and without postoperative macular holes were analyzed using the chi-square test or Fisher exact test. The BCVA was converted to the logarithm of the minimal angle of resolution. The mean age, axial length, and BCVA of the 2 groups were compared using the Mann–Whitney *U* test. Logistic regression models were used to determine the independent effect of each potential factor on development of postoperative macular holes. All P values were 2-sided, with $P < .05$ being considered significant.

RESULTS

FOUR PATIENTS WERE EXCLUDED BECAUSE THE OCT IMAGES were obscured, and 1 patient had undergone a previous pars plana vitrectomy. Forty-two patients with myopic foveoschisis who had undergone a pars plana vitrectomy with ILM peeling were included. The average patient age ± SD at the initial surgery was 66.2 ± 9.3 years (range, 46 to 83 years); 11 (26.2%) patients were men, and 31 (73.8%) women. Twenty-nine (69.0%) eyes were phakic; 13 (30.9%) eyes were pseudophakic. The mean axial length