Myopic Foveoschisis and Macular Hole Retinal Detachment

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4.1 Introduction

Myopic foveoschisis (MF), also known as myopic traction maculopathy (MTM), was first described by Phillips as a localized retinal detachment in highly myopic eyes with a posterior staphyloma and without a macular hole (MH) [1]. Takano and Kishi were the first to use time-domain optical coherence tomographic (OCT) images to describe the morphological characteristics of MF, and they reported it to be a retinoschisis with or without a retinal detachment in the macular area (Fig. 4.1) [2].

More recent OCT studies have shown that MF is a schisis-like thickening of the inner and/or outer retina in highly myopic eyes with a posterior staphyloma. It has been suggested that the schisis-like thickening is due to fluid accumulation caused by traction on the retina rather than a true schisis [3].

It has been reported that MF can progress to a full-thickness MH and subsequent macular hole retinal detachment (MHRD) that is mainly located in the posterior pole but can extend beyond vascular arcade. The MHs in non-myopic eyes are mainly caused by anteroposterior traction by a posterior vitreous detachment, whereas the MHs in highly myopic eyes are caused by multiple anteroposterior and tangential tractional components which induce local or extensive rhegmatogenous retinal detachments. These eyes are difficult to treat because of their multiple and complicated pathogenesis.

MHRDs account for 0.5–21% of all retinal detachments [4, 5], and they are one of the most refractory retinal detachments with high rates of non-closure or reopening of the MHs. Recurrences of the retinal detachment often occur in spite of multiple surgical interventions. The retinal reattachment rate of MHRD has been reported to range from 50% to over 90% [6–8].

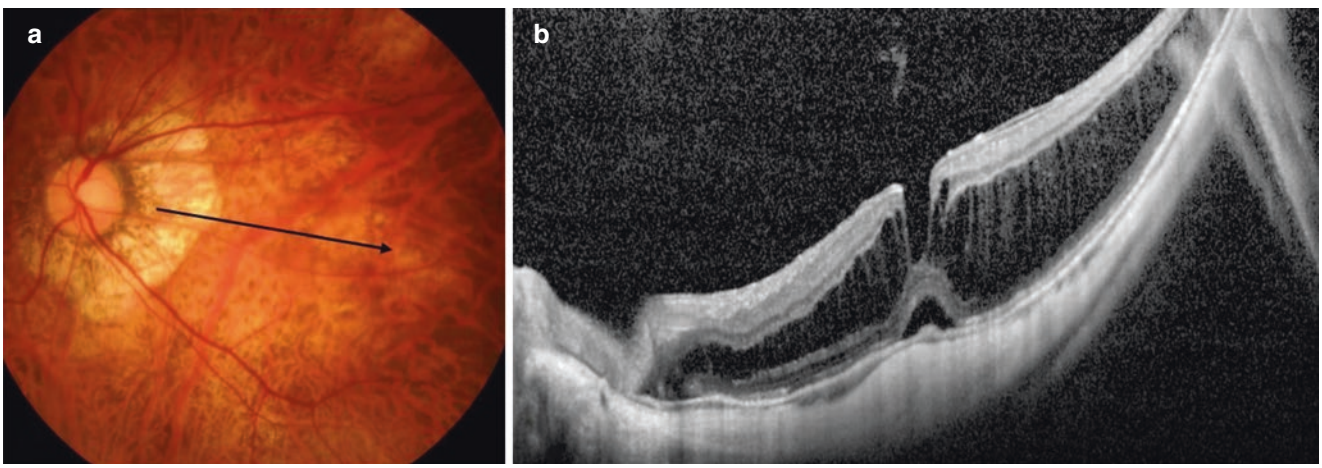

Fig. 4.1 (**a**) Fundus photograph and (**b**) corresponding spectral-domain optical coherence tomographic (SD-OCT) image of a myopic foveoschisis (MF) with macular retinoschisis and foveal retinal detachment. The black line in the fundus photograph is the direction of the SD-OCT scan. The patient was a 61-year-old woman whose decimal best-corrected visual acuity (BCVA) was 0.8

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4.2 Etiopathogenesis

Previous histopathological and OCT studies have shown that multiple tractional components were associated with the pathogenesis of MFs, MHs, and MHRDs in highly myopic eyes. The factors associated with the pathogenesis are preretinal, intraretinal, and subretinal factors. The major preretinal factors are the presence of an epiretinal membrane (ERM) and a partial or non-detached posterior hyaloid membrane which can cause anteroposterior or tangential traction on the retina. An electron microscopic study of the tractional components on the retinal surface of an eye with MHRD showed the presence of vitreous cortex, cellular elements of the ERMs, and the internal limiting membrane (ILM) in the biopsied specimen [9].

The intraretinal factors exerting traction on the retina are a stiffening of the ILM and the retinal vessels which prevent the retina from expanding in the anterior-posterior direction in highly myopic eyes. Bando and associates reported that collagen fibers and glial cells were present in 70% of the ILMs removed during vitrectomy from eyes with MF, and none of these elements were present in the control group consisting of eyes with an idiopathic macular hole. They concluded that the migration of glial cell and synthesis of collagen fibers on the inner surface of ILM contributed to the development of the MF [10].

The subretinal factors associated with MF are posterior staphylomas which are posterior ectasias causing an abnormal contour of the eye wall caused by an elongation of the axial length of highly myopic eyes. This can lead to a centrifugal traction on the retina and contribute to the development of MF. Chorioretinal atrophy is another subretinal factor that can contribute to the development of MF by reducing the attachment between the retina and the pigment epithelium or between the different retinal layers.

The prevalence of pathologic myopia among adolescents and children is less than 0.2% [11, 12], whereas it is 0.9–3.1% among middle-aged and elderly adults in Asian populations [13, 14] and 1.2% in a non-Asian adult population [15]. However, there has not been a study determining the prevalence of MF in a large, non-hospital-based population. Takano and Kishi reported that 11 of 32 highly myopic eyes with posterior staphylomas (34%) had MF [2], and Baba et al. reported that 7 of 78 eyes (9%) with high myopia and a posterior staphyloma had MF [16]. Thus, the incidence of MF is between 9% and 34% in highly myopic eyes of adults.

4.3 Clinical Features

Most of the patients with MF are asymptomatic, and the main complaint of a small number of patients is metamorphopsia. When a foveal retinal detachment and/or MH develop, the complaint is blurred vision. The characteristic biomicroscopic fundus finding in highly myopic eyes with MF is a microcystic appearance or shallow retinal detachment in the macular area.

OCT examinations are more reliable in detecting MFs. The common OCT findings in eyes with MF can be divided into four types that are presented in the order of progression.

- *Retinoschisis*. A retinoschisis is a splitting of the inner or outer retina with bridging columns without a foveal retinal detachment (Fig. 4.2).
- *Retinoschisis with a foveal retinal detachment* (Fig. 4.3).
- *Retinoschisis with a macular hole* (Fig. 4.4).
- *Macular hole retinal detachment* (Fig. 4.5).

The other OCT findings related to the pathogenesis of MFs are a detached ILM (Fig. 4.6), presence of preretinal structures (an ERM, a posterior vitreous membrane; Fig. 4.7), a MH in the inner retinal layer or outer retinal layer (Figs. 4.6 and 4.7), retinal vessel microfolds (Fig. 4.8),

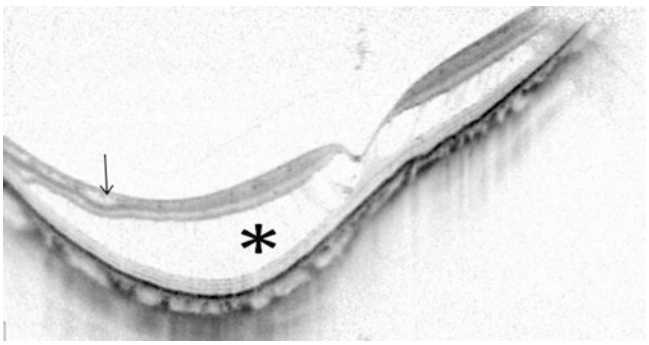

Fig. 4.2 Optical coherence tomographic (OCT) image of an eye with MF showing retinoschisis of the inner (arrow) and outer (asterisk) retinal layer without a foveal detachment. This condition is considered to be the initial stage of MF. The patient was a 70-year-old woman with a decimal BCVA of 0.5

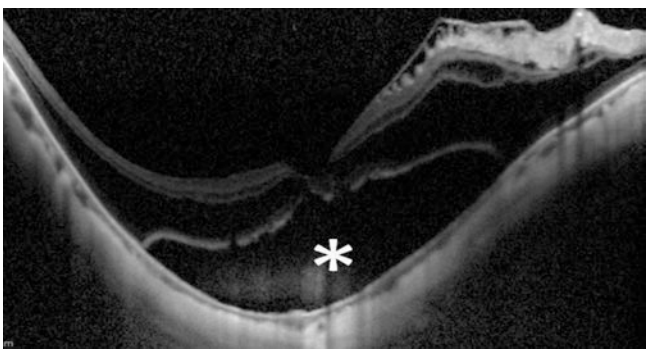

Fig. 4.3 OCT image of an eye with MF which has a foveal retinal detachment (asterisk). The patient was a 63-year-old woman with a decimal BCVA of 0.2

and paravascular microholes (Fig. 4.9). The OCT findings of a detached ILM, presence of preretinal structures on an elevated retina, retinal vessel microfolds, and perivascular microholes indicate an underlying traction of a stiffened ILM, preretinal structures, and retinal vasculature. The MHs in the inner retinal layer and outer retinal layer are caused by a stretching of the retina by various tractional elements and are considered to be precursors to a full-thickness MH.

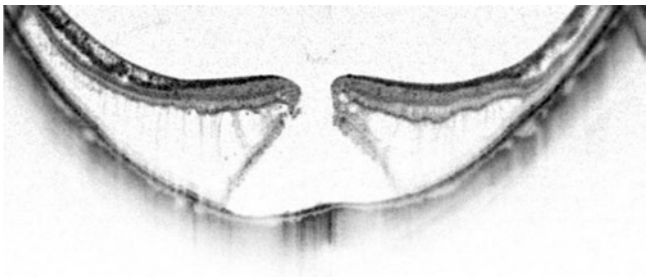

Fig. 4.4 OCT image of an eye with MF with a MH. The MH develops when the roof of a foveal detachment is separated by traction by antero-posterior or tangential components. The patient was a 74-year-old woman with a decimal BCVA of 0.1

4.4 Management

4.4.1 Observation Alone

An MF can remain stable for many years without affecting the vison. However, there are only a few studies on the natural course of MF (Table 4.1) which makes it difficult for surgeons to determine whether the case should be treated or just followed. Shimada et al. performed a longitudinal study of more than 2 years on eight eyes with MF. They reported that two eyes developed a MH and another two developed a foveal retinal detachment [17]. Gaucher et al. reported that 20 of 29 eyes with MF had a

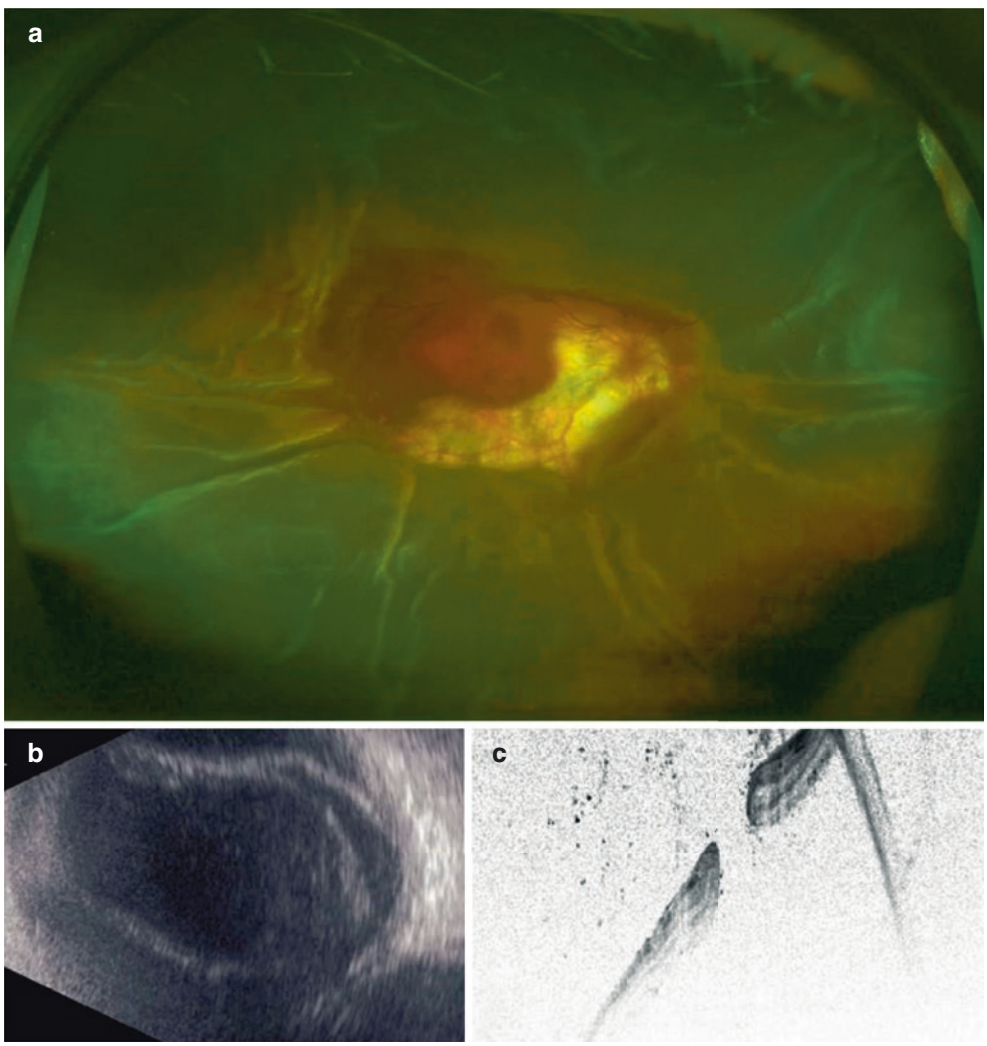

Fig. 4.5 Extensive MHRD following MH formation in an eye with MF. (**a**, **b**) Total retinal detachment associated with choroidal detachment can be seen. (**c**) OCT image showing full-thickness MH. Tangenital tractional components, an ERM, ILM, and retinal vessels, around the MH in the presence of a posterior staphyloma led to this condition. The patient was a 58-year-old woman with a decimal BCVA of 0.03. Intraocular pressure was as low as 5 mmHg with a choroidal detachment

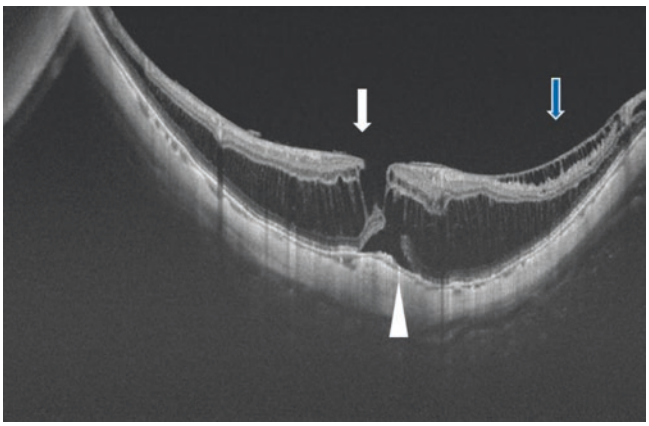

Fig. 4.6 OCT image showing a MH in the inner layer (white arrow), MH in the outer layer (arrowhead), and detached ILM (blue arrow)

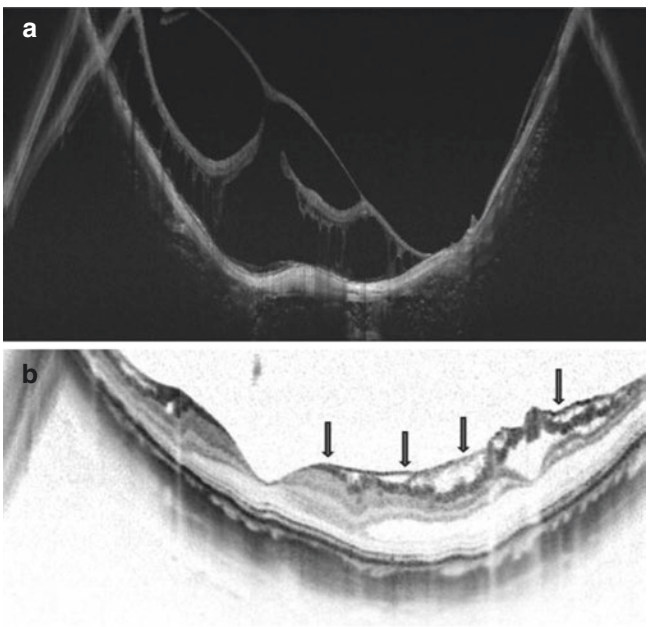

Fig. 4.7 OCT images showing preretinal structures in two eyes with MF. (**a**) Membranous structure which is probably the posterior vitreous membrane exerts traction on the retinal surface in the anteroposterior direction resulting in an outer layer retinoschisis and inner layer MH. (**b**) ERM on retinal surface exerting traction resulting in retinal folds and outer layer retinoschisis (arrow)

decrease of the visual acuity during a 31-month natural course study. They concluded that eyes with MF and the presence of premacular structures have a higher risk of progressing to a reduction in the visual acuity. In addition, those with a foveal detachment develop MHs more frequently whether or not surgery is performed. However, most of the cases without these findings remained stable during the 31-month follow-up period [18]. The results of these studies might suggest that many MF cases can progress to a more severe stage.

However, there have been other reports on a spontaneous resolution or none progression for several years of MFs (Fig. 4.10). Shimada et al. reported that only 11.6% of MF cases progressed which is much more stable than previously reported [19]. In addition, a spontaneous resolution of the MF with release of posterior vitreous traction has been reported [20], and a spontaneous resolution of four cases of MF with a release of posterior vitreous traction and reduced tangenital traction with ILM dehiscence have been reported [21]. Thus, the optimal time for surgery has not been definitively determined in eyes with MF. Many surgeons have reported that a progressive visual reduction and/or the presence of metamorphopsia are indications for surgery. This is because MF cases without foveal retinal detachment, traction by preretinal structure, or decreased vision may not require immediate surgical intervention. However, surgery is indicated for most cases that develop a MH or a MHRD.

4.4.2 Vitreoretinal Surgery

In the majority of earlier studies, the primary treatment for eyes with MF was vitrectomy with or without ILM peeling and with or without a gas tamponade. Some surgeons preferred macular buckling or scleral imbrication alone or in combination with vitrectomy. Ikuno et al. reported on 44 eyes with MF including 11 eyes with a full-thickness MH that underwent vitrectomy, ILM peeling, and gas tamponade. They reported that the retinoschisis with or without foveal retinal detachment was resolved in all of the eyes, the MH was closed in 4 of 11 eyes, and the visual acuity improved mostly in eyes with foveal retinal detachment [22].

The major postoperative complication of vitrectomy for MF without a MH is the formation of a MH and subsequent MHRD. Gaucher et al. suggested that when MF is combined with foveal retinal detachment, a MH develops more frequently whether surgery is performed or not performed [18].

The use of ILM peeling is still controversial. Taniuchi et al. reviewed 71 eyes of 64 patients with MF who underwent vitrectomy with or without ILM peeling, and they concluded that a recurrence of MF developed more frequently in eyes without ILM peeling [23]. Peeling a rigid ILM reduces tangential traction on the retina and promotes retinal reattachment. However, it can increase the risk of causing an iatrogenic MH on a thin retina of highly myopic eyes, and there are cases not requiring ILM removal for retinal reattachment (Fig. 4.11). To reduce the risk of postoperative MH formation in eyes that undergo ILM peeling, Shimada et al. compared the effects of fovea-sparing ILM peeling to complete ILM peeling on 45 consecutive eyes that underwent vitrectomy for MF. They reported that a

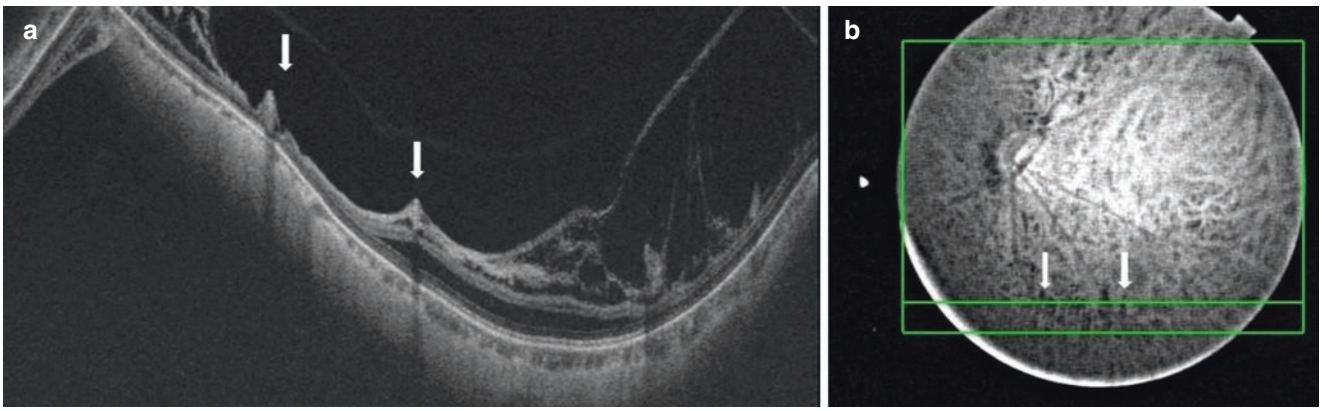

Fig. 4.8 (**a**) OCT image and (**b**) fundus photograph of retinal vascular microfolds. Tentlike elevations in the inner retina in the OCT image are located along the retinal vessels in the fundus photograph (arrows). These findings indicate an inward traction by the retinal vessels in an eye with a posterior staphyloma

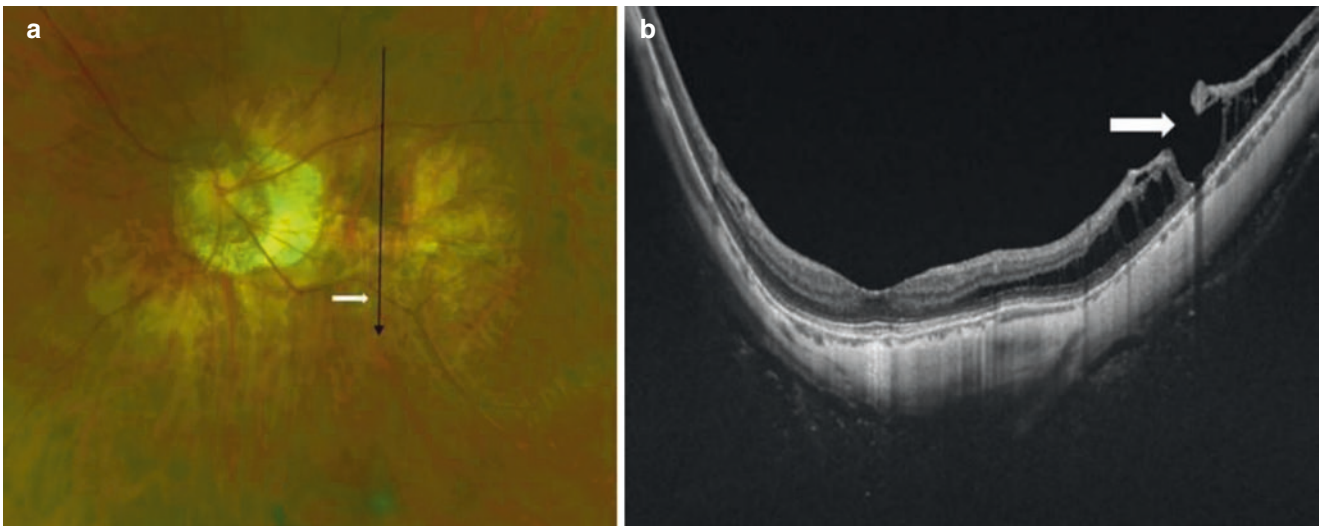

Fig. 4.9 (**a**) Fundus photograph and (**b**) OCT image of the same highly myopic eye. OCT image shows a perivascular microhole (white arrow) caused by an inward traction of a retinal vessel

Table 4.1 Major studies on the natural course of myopic foveoschisis (MF)

	Follow-up period	Progressed	Stable	Improved
Shimada et al. [17]	More than 2 years	4/8(50%)	4/8(50%)	0/8(0%)
Gaucher et al [18]	Mean 31.2 months	20/29(69%)	9/29(31%)	0/29(0%)
Shimada et al. [19]	More than 2 years	24/207(11.6%)	173/207(85.1%)	8/207(3.6%)

The latest report in 2013 shows a more stable natural course than the earlier two reports

MH developed in 5 of 30 eyes (16.7%) in the complete ILM peeled group and none of the 15 eyes in the fovea-sparing ILM peeling group [24] (Fig. 4.12).

In eyes with a full-thickness MH or a MHRD which is considered the end stage of MF, vitrectomy in combination with ILM peeling with gas or silicone oil tamponade, macular buckling with or without vitrectomy, and scleral imbrication with vitrectomy have been performed. Michalewska et al. introduced an inverted ILM flap technique for large MHs [25]. Since then, some investigators have used this technique for MH and MHRD in highly myopic eyes (Figs. 4.13 and 4.14). They have reported higher MH closure rates than only ILM peeling and favorable retinal reattachment rates. Baba et al. compared the efficacy of vitrectomy with or without the inverted ILM flap technique in 21 highly myopic eyes with a MHRD. They reported that the MH

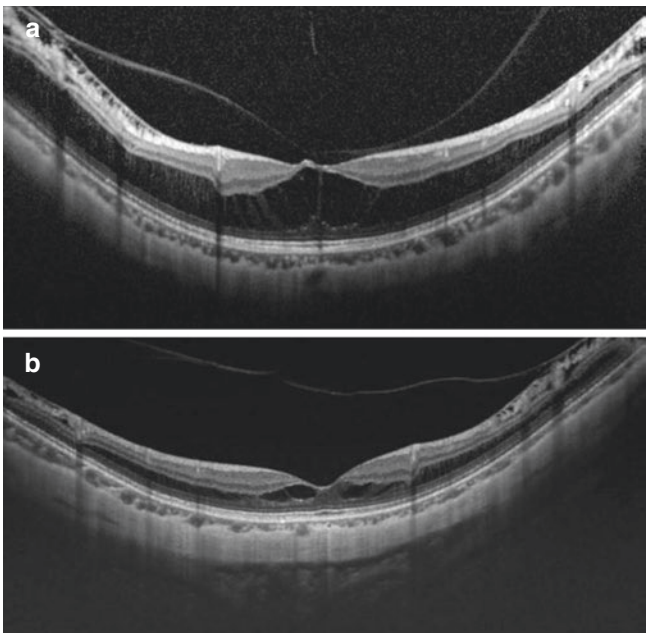

Fig. 4.10 (**a**) 69-year-old woman presented with metamorphopsia with decreased BCVA (0.3). OCT image shows retinoschisis with perifoveal posterior vitreous detachment (PVD). (**b**) After 12 months without intervention, the BCVA has improved to 0.8, and OCT shows a resolution of MF with progression of the PVD

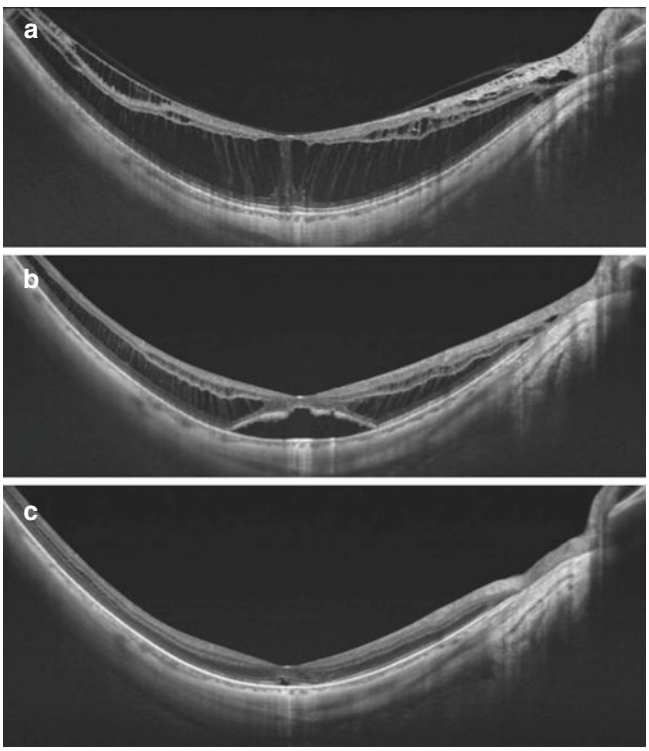

Fig. 4.11 OCT image of an eye with MF that underwent vitrectomy without ILM peeling. (**a**) In the preoperative OCT image, preretinal structures are not seen except for a shallow PVD, and the deformation of the inner retinal surface was slight. (**b**) One month after surgery, a decrease of the retinoschisis and development of foveal retinal detachment can be seen. (**c**) Two years after surgery, retina is almost completely reattached without retinoschisis. The creation of a PVD without ILM peeling was sufficient for retinal reattachment in this case. The patient was a 49-year-old man whose decimal BCVA improved from 0.3 to 0.4

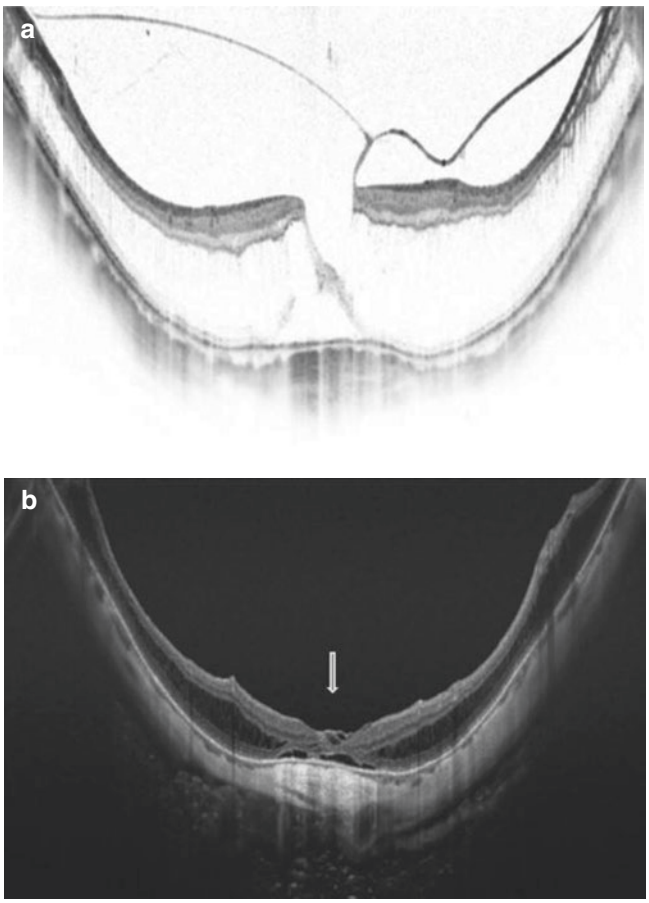

Fig. 4.12 (**a**) OCT images of an eye with MF accompanied by a MH passing through the inner and outer retinal layers. The risk of developing a postoperative full-thickness MH was high. (**b**) After vitrectomy with fovea-sparing ILM peeling, the MF was significantly reduced without a full-thickness MH. Note the remnant of the ILM in the postoperative OCT image (arrow). The patient was a 75-year-old woman whose decimal BCVA improved from 0.4 to 0.7

closure rate was 80% in ILM flap group which was significantly higher than that of complete ILM peeling (36%). The retinal reattachment rate was 100% in the ILM flap group and 91% in the ILM peeling group, and this difference was not statistically significant [26].

Macular buckling with silicone sponge or macular plombe is used alone or in combination with vitrectomy for complicated cases as an initial treatment for highly myopic eyes with MHs. Ando et al. compared the surgical outcomes of macular buckling alone to that of vitrectomy alone as the primary procedure for MHRDs in highly myopic eyes. They reported that the initial reattachment rate was 93.3% in the macular buckling group and 50% in the vitrectomy group [27]. By shortening the axial length of the eye and altering the shape of a posterior staphyloma, macular buckling reduced the anteroposterior and tangential vitreoretinal traction thus promoting macular attachment and MH closure (Fig. 4.15). However, due to technical difficulties and possible complications such as subretinal hemorrhage which

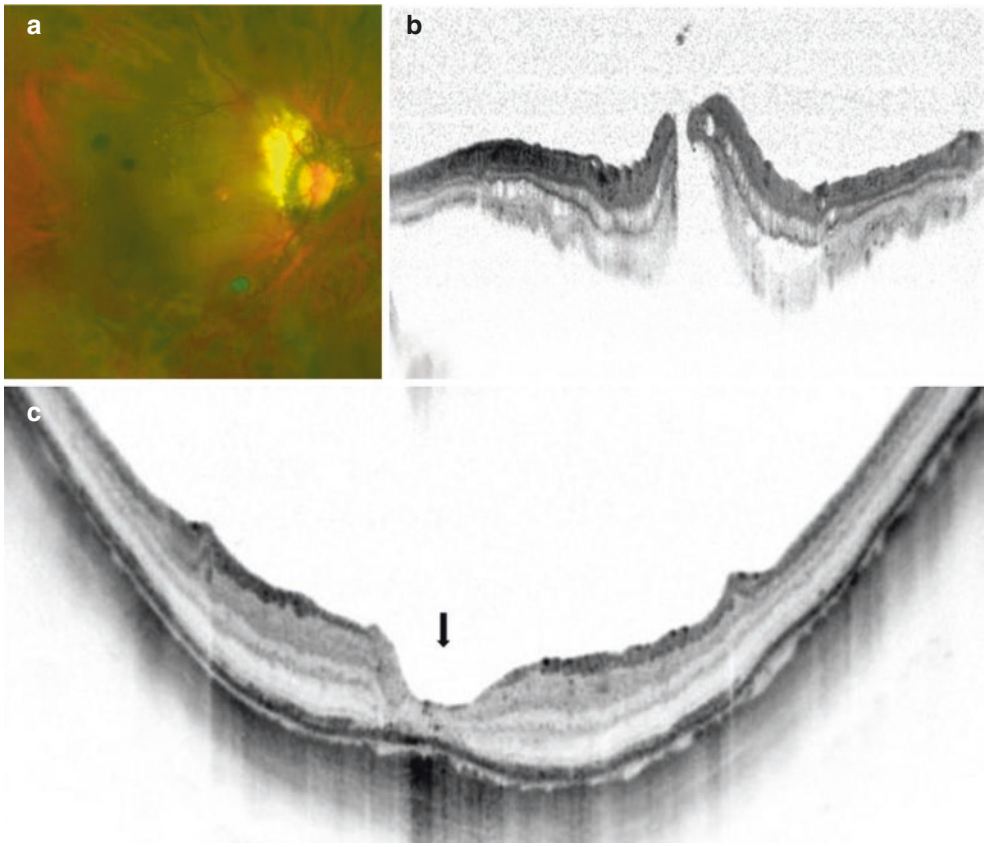

Fig. 4.13 Fundus photographs and SD-OCT images of the retina after vitrectomy with the inverted ILM technique. (**a**, **b**) The MHRD can be seen to extend beyond the vascular arcade. (**c**) The MH is closed with glial tissue substituting for foveal sensory retina, and the EZ is not seen (white arrow). The patient was a 62-year-old woman whose decimal BCVA improved from 0.04 to 0.2

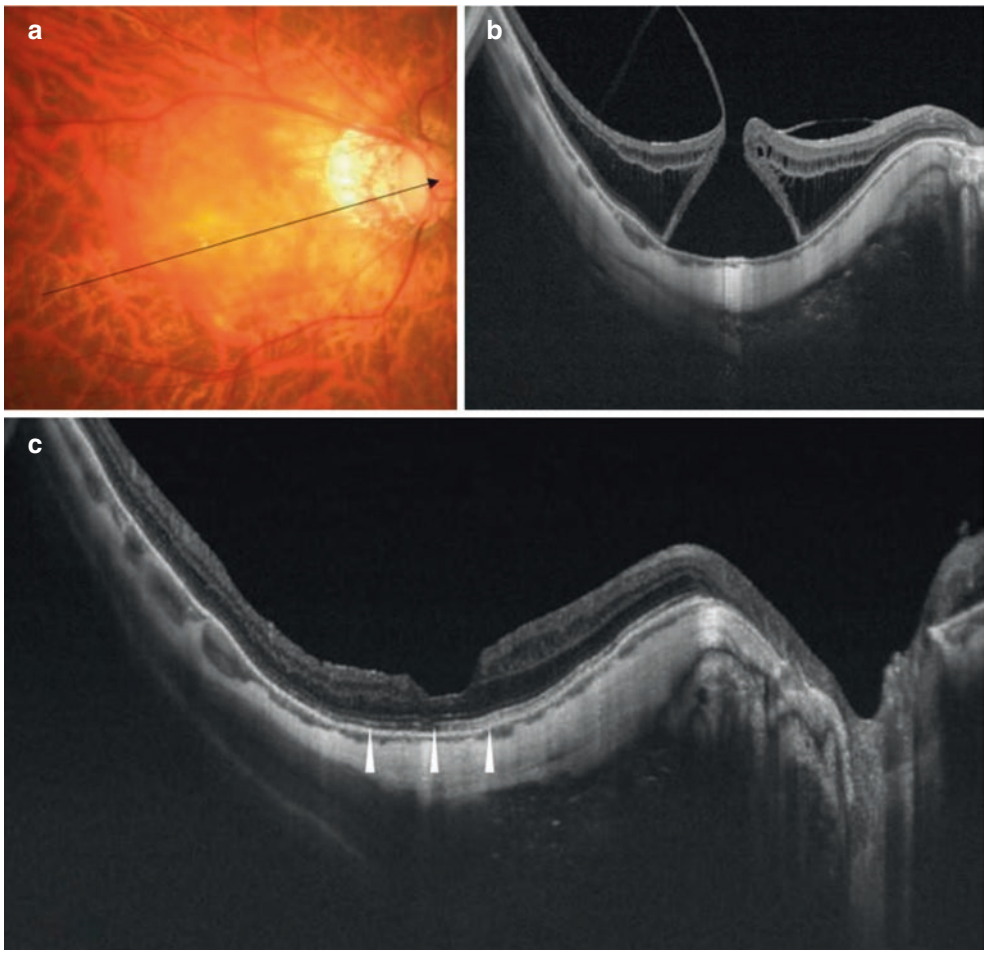

Fig. 4.14 Fundus photographs and SD-OCT images of the retina after vitrectomy with the inverted ILM technique. The images show different patterns of MH closure compared to the case shown in Fig. 4.13. (**a**, **b**) MF with full-thickness MH can be seen. (**c**) The MH is closed with a preservation of the EZ and the sensory retina (arrowhead). The patient was a 67-year-old woman whose BCVA improved from 0.2 to 0.7

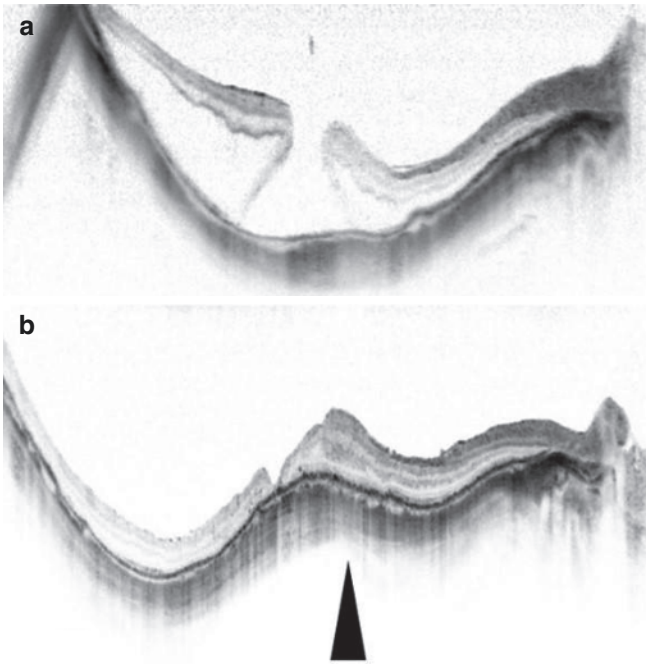

Fig. 4.15 Pre- and postoperative OCT images of two eyes that underwent vitrectomy with macular Ando plombe. (**a**) MF with full-thickness MH is seen in the OCT image. (**b**) Postoperative OCT image showing an indentation by the macular Ando plombe which changed the shape of the posterior staphyloma markedly leading to MH closure (arrowhead). The patient was a 68-year-old woman whose decimal BCVA improved from 0.1 to 0.5

can lead to chorioretinal atrophy and progression of myopic choroidal neovascularization, this technique tends to be used only in difficult cases in which vitrectomy alone is insufficient for retinal reattachment.

Scleral imbrication is also used in combination with vitrectomy to treat highly myopic eyes with MHs, and favorable results have been reported. Fujikawa et al. reported on eight highly myopic eyes with a MHRD that underwent vitrectomy combined with scleral imbrication. The retina was reattached in all eyes, and the MH was closed in six eyes (75%) [28]. The therapeutic mechanism for this procedure is a shortening of the axial length and alteration of the shape of the posterior staphyloma which is similar to that of macular buckling. Ando et al. reported on 17 eyes that underwent vitrectomy with scleral imbrication for MF or MHRD. They reported a decrease in the axial length and changes in the curvature of the posterior staphyloma at 1 month after surgery on 17 eyes that underwent vitrectomy with scleral imbrication for MF or MHRD. However, the change in the scleral curvature of the posterior staphyloma regressed at 3 and 6 months postoperatively [29]. This technique may have an advantage because the surgeon can avoid complications related to direct macular indentation although its impact on the axial length and shape of a posterior staphyloma may be less than that of macular buckling (Fig. 4.15). In addition, the effects of the surgery may reduce over years (Fig. 4.16).

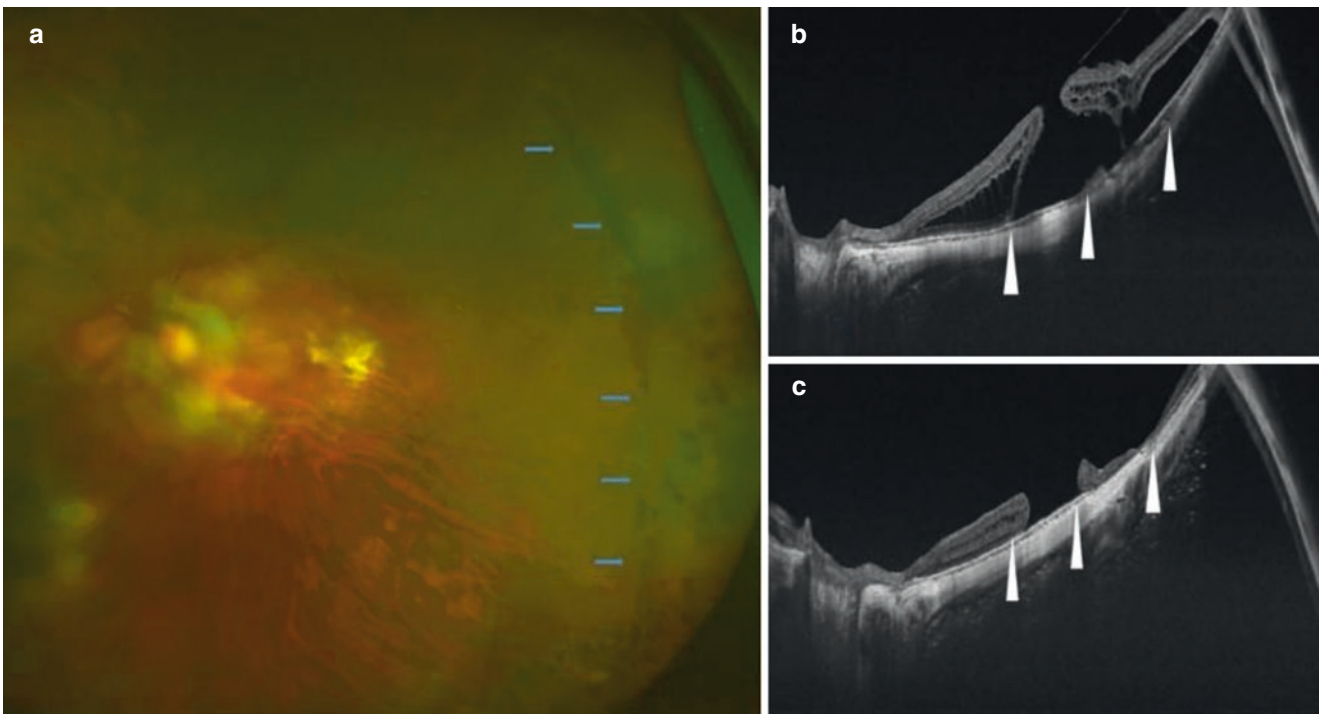

Fig. 4.16 Wide-field fundus photograph and OCT image of an eye that underwent vitrectomy with scleral imbrication. (**a**) Fundus photograph shows a protrusion created by the scleral imbrication (arrows). (**b**) Preoperative OCT image shows MF with full-thickness MH. (**c**) After vitrectomy with scleral imbrication, the change in curvature of posterior eye wall can be seen in the OCT image (arrowhead), but the MH remains opened. The patient was a 61-year-old woman whose BCVA improved from 0.1 to 0.2

4.5 Conclusions

A myopic foveoschisis (MF), also known as myopic traction maculopathy (MTM), is a tractional macular retinal thickening in patients with high myopia and posterior staphyloma with or without a macular hole. OCT is the main diagnostic method to detect MFs and determine the morphology of vitreoretinal interface which are difficult to detect by standard ophthalmoscopy. Although there exist many cases of MF without symptoms, a worsening of the BCVA, or the OCT findings, some cases can progress to a more severe stage. In such cases, surgery including vitrectomy in combination with other procedures is recommended. However, the best time to perform the surgery has not been determined because of a possibility of a spontaneous resolution or non-progression of the MF and possible postoperative complications. At present, careful OCT examinations and monitoring the changes of the BCVA are recommended. These findings should lead to a better understanding of the pathogenesis, pathology, and treatment of MF.

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