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REVIEW ARTICLE

Anatomical and visual outcomes in high myopic macular hole (HM-MH) without retinal detachment: a review

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Abstract

Purpose To review postoperative anatomical and functional outcomes in high myopic macular hole (HM-MH) without retinal detachment.

Methods In the PubMed database, published articles on myopic macular hole surgery from 2000 to 2013 (present days) were reviewed. Inclusion criteria were high myopia and macular hole (MH). Series with posterior retinal detachment secondary to MH and myopic foveoschisis (MFS) without MH were excluded. Main outcomes included MH closure rate, resolution of the foveoschisis, if present, and postoperative visual acuity. Optical coherence tomography (OCT) features and postoperative evolution were also evaluated when reported.

Results A total of 131 articles were initially found. After having applied the exclusion criteria, 15 articles were reviewed. Four were focused on HM-MH with concomitant foveoschisis (Schisis Group), and ten included only HM-MH without FS case series (Flat Group). Only one comparative study between these two groups was found. Surgical techniques were observed to be similar for both groups in most series, including vitrectomy with or without internal limiting membrane (ILM) removal, and gas or silicone oil tamponade. However, in one retrospective study, macular buckling was applied together with pars plana vitrectomy in cases of HM-MH with foveoschisis. When available, preoperative and postoperative OCT provided a useful evaluation of the status of the macula. Different prognosis were observed in the two groups in cases of vitreous surgery: anatomical success rate and functional outcomes for HM-MH with foveoschisis were markedly poorer than that for cases of HM-MH without foveoschisis, and multiple procedures might be required. By the contrast, better results seemed to be achieved using the posterior buckle technique for patients with HM-MH and concomitant foveoschisis. Moreover, when compared, final anatomical and functional outcomes seem to be less satisfactory than in emmetropic eyes. Postoperative non-closure or reopening of the macular hole is more common in eyes with HM-MH and concomitant foveoschisis, and possible retinal detachment may occur in these patients.

Conclusions Despite similar surgical procedures, anatomical and functional results after vitreous surgery in cases of HM-MH may be very different from series to series. The prognosis is generally better in cases involving only HM-MH without foveoschisis than in cases with MH and associated foveoschisis. Persistent MHs are more frequent in eyes with concomitant retinoschisis, and this seems to represent a possible risk factor for late retinal detachment in the case of unsuccessful vitreous surgery. However, although vitrectomy can lead to anatomical and visual improvements, an higher axial length> 30 mm and the presence of a posterior staphyloma seem to remain the two most important risk factors for poor

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visual outcomes. For these reasons, a different surgical approach, including macular buckling, might be considered in casse of HM-MH and concomitant myopic foveoschisis, in order to counteract the traction exerted by the posterior staphyloma.

Keywords Macular hole · High myopia · Foveoschisis · Surgery

Introduction

Although macular hole (MH) has been recognized as more frequently idiopathic, it can also be observed as a common complication in highly myopic eyes (> 26.5 mm in axial length and/or>-6.00 dioptres) [1–3]. The abnormal growth of the posterior wall of these eyes may lead to a progressive scleral ectasia of the globe known as posterior staphyloma (PS) [4], which can be associated with a full thickness MH with or without foveoschisis (FS) and retinal detachment (RD) [5–7].

Regarding MH without FS, it has been postulated that highly myopic eyes with PS could be affected by MH exactly as occurs in emmetropic eyes, as far as the pathogenetic mechanism is concerned [8, 9]. This could probably be explained by the different depths of the PS, which involves the macular region. In deeper PS, which often extends within the temporal vascular arcades, centripetal vector forces exerted toward the center of the eyeball are greater than in eyes with a flat PS [5]. As a consequence, since the relative inelastic inner retina tends to resist the anteroposterior traction exerted by the staphyloma, the retina can split, leading initially to a myopic FS (9–34 %) and finally to a posterior RD.

On the contrary, in the case of a flat PS, this may not be sufficient to produce anteroposterior tractional forces that lead to a concomitant FS or a RD [8–10], and a MH may develop exactly as occurs in emmetropic eyes.

Several surgical procedures are available for MH repair in high myopia, including pars plana vitrectomy (PPV) with gas or silicone oil tamponade, episcleral posterior buckling, suprachoroidal buckling and scleral shortening technique [11–15]. Moreover, although spontaneous closure of a recurrent high myopic macular hole (HM-MH) can occur [16], some patients require multiple interventions to achieve MH closure [17–19].

In light of all these considerations, and since several reports have described different anatomical success results of HM-MH surgery, especially when comparing MH with or without FS, we aim to review all previously published articles trying to clarify why anatomical and functional outcomes may be so different from series to series.

Methods

In the PubMed database, published articles from 2000 to 2013 (present days) were searched by using the headings macular hole (MH) in high myopia (HM), and the keywords *myopic foveoschisis*, *pars plana vitrectomy* (*PPV*), *internal limiting membrane* (*ILM*), *macular buckling*, *intraocular tamponade*, *gas*, *silicone oil* and *optical coherence tomography* (*OCT*) were inserted, combined in different ways. Only articles in the English language were considered, and all type of studies (retrospective and prospective, comparative, randomized and single-center or multicenter) were included. Case series with posterior retinal detachment secondary to HM-MH, as well as myopic FS with or without foveal detachment, but without a macular hole, were excluded.

Studies were divided into two groups, depending on the presence of a concomitant myopic foveoschisis or not. For better comprehension, these two groups were named according to the classification of Jo et al. [10].

Type of study, number of eyes included, age, degree of myopia (Spherical Equivalent and/or Axial Length), use of the OCT and ILM peeling, as well as MH closure rate, improvements of best corrected visual acuity (BCVA) and resolution of the foveoschisis, if present, were reported as described in Tables 1, 2, and 3. Postoperative retinal detachment rate secondary to persistent MH was also evaluated. Comparative studies, if present, were evaluated separately. Case reports were not included in the tables, but are discussed in the manuscript's text.

Results

We found 131 published articles on HM-MH in the PubMed database. Fifteen articles were focused on surgical outcomes and were analyzed. Ten were focused on HM-MH without FS (*Flat Group*) and published from 2000 to 2013 (Table 1). On the contrary, regarding HM-MH with concomitant MFS (*Schisis Group*), only two retrospective studies were published; in 2006 by Ikuno et al. [20] and in 2013 and by Burès et al. [21], respectively (Table 2). In both, PPV was performed, but in the latter, macular buckling was applied in addition to vitreous surgery. Two other case-reports were also evaluated. Finally, only one comparative case-series between the two groups was considered and reviewed (Table 3).

HM-MH without foveoschis (*Flat Group*)

Table 1 summarizes the data concerning the ten published studies mentioned above.

In the last decade, the first published study was conducted in 2000 by Sulkes et al. [22], followed by the series of Patel et al. [23] and Garcìa-Arumi et al. [24] in 2001. In those series,

Table 1 Previous studies on vitreous surgery in high myopic macular hole (HM-MH) without foveoschisis (*Flat Group*)

	StudyDesign (P/R/C)	Eyes	Mean Age (y)	Myopia Degree	MH closure rate (1° surgery)	MH closure rate (2° surgery)	OCT	ILM peeling	BCVA improvement (%)	Postoperative MMHRD rate
Sulkes et al. [22] (2000)	R	13	55	-10.30 SE	69.2 %	77 %	NO	NO	54 %	7.7 % (1 eye)
Patel et al. [23] (2001)	R	20	56	-7.48 SE	60 %	85 %	NO	NO	40-55 %	NO
Garcia-Arumi et al. [24] (2001)	R	24	40	28.75 AL	87.5 %	100 %	NO	41.6 % (10/24)	83.3 %	NO
Kobayashi et al. [8] (2002)	NO statistically significant difference in area, volume or depth of MH between high myopic and emmetropic eyes: P/C	20 (94)[a]	52.1	> 26 AL	NO statistically significant difference in MH closure rate between high myopic and emmetropic eyes: 80 %		YES	NO	N/A	N/A
Kwok et al. [25] (2003)	P/C	10 (20)[a]	48.3	27.7 AL	90 % (both groups)		NO	YES	60 %	NO
Suda et al. [26] (2011)	R/C	15 (52)[a]	56	> 26 AL	73.3 % (92 %→26<AL<30) (0 %→AL>30)		YES	YES	-	13.3 % (2 eyes)
Qu et al. [27] (2012)	R/C	12 (24)[a]	50.1	-8.50 SE	100 % (both groups)		YES	YES	67 %	NO
Wu et al.[28] (2012)	R/C	8 (42)[a]	54	-13.50 SE 28.89 AL	62.5 %		YES	YES	50 %	NO
Alkabes et al. [9] (2013)	R	42	55	-14.98 SE	83.3 %	90.5 %	YES	YES	52.4 %	NO
Kuriyama et al. [29] (2013)	R	4 (10)[a]	45.5	29.77 AL	75 % (3/4)	N/A	YES	YES (all)	25 % (1/4)	NO

AL axial length (millimeters); *BCVA* best corrected visual acuity; *C* comparative; *ILM* internal limiting membrane; *MMHRD* retinal detachment from myopic macular hole, *OCT* optical coherence tomography; *P* prospective; *R* retrospective; *SE* spherical equivalent (diopters); *RRD* rhegmatogenous retinal detachment; *y* years

[a] Total amount of eyes enrolled in the study (included emmetropic eyes as control cases)

Table 2 Previous studies on high myopic macular hole (HM-MH) with foveoschisis (*Schisis Group*)

	Study Design (P/R/C)	Eyes	Mean Age (y)	Myopia Degree	Surgical Technique	FS resolution rate	MH closure rate (1° surgery)	MH closure rate (2° surgery)	OCT	BCVA improvement (%)	Postoperative MMHRD rate
Ikuno et al. [20] (2006)	R	8	63.1	-9.2 SE 29.0 AL	PPV	100 %	12.5 %	25 %	YES	37.5 %	N/A
Burès et al. [21] (2013)	R	16	52.1	-16.5 SE 30.1 AL	MB+PPV	100 %	100 %	N/A	YES	81.25 %	None

AL axial length (millimeters); *BCVA* best corrected visual acuity; *C* comparative; *ILM* internal limiting membrane; *MB* macular buckling; *MMHRD* retinal detachment from myopic macular hole; *OCT* optical coherence tomography; *P* prospective; *PPV* pars plana vitrectomy; *R* retrospective; *SE* spherical equivalent (diopters); *y* years

Table 3 Previous comparative studies on high myopic macular hole (HM-MH) with versus without foveoschisis (Schisis Group vs. Flat Group)

	Study Design (P/R/C)	Eyes	Mean Age (y)	Myopia Degree	ILM peeling	MH closure rate (1° surgery)	MH closure rate (2° surgery)	OCT	BCVA Improvement (%)	Postoperative MMHRD rate
Jo et al. [10] (2012)	R/C	10 (Schisis Group)	66.7	-11.6 SE 29.5 AL	YES	50 % (5/10)	-	YES	20 %	NO
	R/C	9/12 (Flat Group)	57.4	-9.8 SE 29.4 AL	YES	78 % (7/9)	-	YES	44 %	NO

AL axial length (millimeters); *BCVA* best corrected visual acuity; *C* comparative; *ILM* internal limiting membrane; *MMHRD* retinal detachment from myopic macular hole; *OCT* optical coherence tomography; *P* prospective; *R* retrospective; *SE* spherical equivalent (diopters); *RRD* rhegmatogenous retinal detachment; *y* years

13, 20 and 24 high myopic eyes with MHs were treated with PPV. The ILM was peeled off only in some of Garcia-Arumi's cases (10/24 eyes). Among these three series, MH closure rate ranged from 60 % to 87.5 % after one surgery, increasing to 77–100 % with a second surgical approach. Visual acuity improved in 40–55 % of patients in the first two studies, and in 83.3 % of patients in the latter. Postoperative OCT was not performed in any of these series. A case of posterior RD due to MH was reported after surgery in the study of Sulkes et al. [22]

In 2002 and 2003, two prospective-comparative studies were designed and published to report anatomical and functional outcomes after PPV in both HM-MH and idiopathic MHs in emmetropic eyes [8, 25]. In the study of Kobayashi et al. [8], preoperative and postoperative outcomes in 20 HM eyes with MH were compared to those observed in 74 emmetropic eyes with idiopathic MH. No statistically significant difference regarding the preoperative MH configuration was reported between the two groups. MH closure rate was 80 %. Data concerning postoperative visual acuity was not reported. In the series of Kwok et al. [25], ten eyes with HM-MH and ten with idiopathic MH underwent PPV with ILM peeling. MH was closed in 90 % of patients in both groups. Two cases of rhegmatogenous RD within 2 months were reported among patient with high myopia.

Several years later, in 2011, Suda et al. [26] documented a 73.3 % of MH closure rate after vitreous surgery in 15 HM patients. Nevertheless, in every case with an axial length > 30 mm, the MH remained open. Moreover, two eyes developed a RD secondary to a persistent MH. In one of them the axial length measured 31.89 mm, and in the second it was 26.0 mm or more, but less than 30.0 mm. More recently, two case–control studies [27, 28] showed a primary MH closure rate of 100 % and 62.5 % in 12 and eight HM patients, respectively. In the former, mean preoperative refractive error was –8.50 D and the anatomical success rate was similar to that observed in the comparative group made up of 12 emmetropic patients. Visual acuity improved in 50–67 % of patients, and a rhegmatogenous RD occurred in one eye of each series within few months after surgery.

In the last year, Alkabes et al. [9] evaluated 42 patients with an HM-MH who were treated with PPV, ILM peeling and gas tamponade. Primary and final MH closure rates were 83.3 % and 90.5 %, respectively. None of these patients had a myopic foveoschisis, even if 64 % (27/42) of them showed a posterior staphyloma and in three of them, the MH was located just in the apex of the staphyloma. Interestingly, in two of these three cases, the MH remained open after surgery. In this study, seven preoperative OCT parameters related to the MH size were analyzed to assess their potential role as prognostic factors in myopic MH surgery. Only Hole Form Factor (HFF) and the MH minimum diameter showed a statistically significant correlation with postoperative visual acuity. Measurements of axial lengths and height of the posterior staphyloma were not recorded. Despite a high anatomical success rate, BCVA improved in 52.4 % of patients.

In the last published series by Kuriyama et al. [29], ten high myopic patients were evaluated. Four of them had a MH and underwent PPV with inverted ILM flap technique [30], achieving a MH closure rate of 75 % (3/4). Postoperative BCVA improved in one patient, remained stabile in two and got worse in one. The same surgical procedure was successfully applied in two other patients with MH and associated FS in this study.

HM-MH with foveoschisis (*Schisis Group*)

The first two published studies were case-reports. In 2003, Ikuno et al. [31] published a report of two cases of HM-MH with FS and foveal detachment who underwent PPV with ILM peeling (2–3 disk diameters) and intraocular gas tamponade. Mean axial length was 30.1 mm. Postoperatively, both patients presented with an enlarged macular hole, resulting in progressive retinal detachment soon after the gas disappeared. After the second treatment with 16 % perfluoropropane tamponade, the retinal detachment and retinoschisis resolved in both patients, but the MH remained open in one.

In 2004, Mastumura et al. [32] reported a 79-year-old woman and a 52-year-old woman who on fundus and OCT examinations showed MH and MF. No data were reported concerning the axial length. Pars plana vitrectomy, ILM peeling and gas tamponade were performed. Six months later, the MF resolved in both cases, but the MHs remained open.

Successively, two other retrospective cohort studies were found and reviewed. In the series published in 2006 by Ikuno et al. [20], eight patients underwent vitrectomy for MH associated with MFS (Table 2). Reoperation was performed for persistent MHs in three patients, and an additional fluid-gas exchange was performed in two, using 16 % C3F8. The ILM was peeled extensively (5–6 disk diameters) in all the second surgeries. The foveoschisis resolved in all eyes. The MH closed in one eye (12.5 %) after the initial surgery and with additional gas tamponade in another (12.5 %). Nevertheless, the MH remained open and enlarged in six (75 %). The mean preoperative and postoperative BCVA were 20/200 and 20/130, respectively.

More recently, in the series of Burès et al. [21], 16 patients underwent macular buckling in addition to PPV, ILM peeling and intraocular gas tamponade. Three of them had had previous vitreous surgery and one still had silicone oil in-situ. Preoperatively and postoperatively, all patients were evaluated using the spectral domain optical coherence tomography (SD-OCT) technique. MH was closed and foveoschisis resolved in all cases. Postoperative visual acuity improved in 81.25 % of patients. In one case, the exoplant was removed due to extrusion 7 months after surgery. However, the MH remained closed and MFS did not reappear.

HM-MH with foveoschisis (*Schisis Group*) versus HM-MH without foveoschis (*Flat Group*)

Only one retrospective-comparative study comparing these two groups of patients, published in 2012, was found in the database (Table 3). In the series by Jo et al. [10], ten HM eyes were affected by MH with FS (Schisis Group) and 12 had only a MH (Flat Group). Three of these 12 cases went missing during the follow-up. Mean axial length was similar in both groups (29.5 mm and 29.4 mm, respectively). Pars plana vitrectomy, ILM peeling and intraocular gas tamponade were performed in all cases. After one surgical approach, the MH closure rate was 50 % (5/10 patients with MH and FS) and 78 % (7/9 patients with only MH), respectively. A better improvement in visual acuity was observed in the “Flat Group” rather than in the “Schisis Group”. These rates were 44 % and 20 %, respectively.

Discussion

Since the surgical technique continues to play an important role in macular hole surgery, especially in high myopic eyes in which it still remains controversial, we reviewed several previous studies that were focused on the anatomical and functional outcomes in these patients.

It is well known that high myopia may be associated with the presence of a posterior staphyloma, which is a progressive scleral ectasia caused by axial elongation. Different types of staphylomas may exist, according to the Classification of Curtin [4], and each one could have its own depth, leading to stronger or weaker anteroposterior tractions. In case of a deep staphyloma, a certain degree of neuroretinal splitting may occur due to a limited elasticity of the retina caused by the ILM [33] and retinal vessels [34]. As a consequence, a myopic foveoschisis may develop, and although it can remain stable for years, its progression to a full-thickness MH and posterior RD is frequently reported [35]. On the contrary, in the case of a flat but no deep myopic staphyloma, anteroposterior traction may be weaker and does not lead to separation of the intraretinal layers [5]. Thus, since tangential forces are also involved, several quthors have proposed that in some cases, high myopic patients can be affected by MH exactly as occurs in emmetropic eyes, without risk of retinal detachment [10, 26–28]. Moreover, when comparing HM-MH with and without retinoschisis, it has been postulated that they may be considered two different entities regarding their pathogenesis and evolution, as well as their visual and surgical outcomes [10]. This may explain why these two types of macular holes were considered and analyzed separately by the authors (*Schisis Group* vs. *Flat Group*).

Regarding HM-MH without foveoschisis (*Flat Group*), in the recent published series of Alkabes et al. [9], primary MH closure rate (83.3 %) seemed superior to the success rate reported by Sulkes et al. (62.9 %) [22] and Patel et al. (60 %) [23]. The authors suggested that this could be explained by the lack of ILM peeling in those previous studies, proposing that ILM removal could play an important role in increasing MH closure in severely myopic eyes compared to non-peeled eyes [25]. Nevertheless, exactly as occurs in emmetropic eyes, ILM peeling should be carefully considered, since it seems to produce postoperative inner retinal defects in the retinal nerve fiber layer that could affect functional outcomes [36, 37]. Also Garcìa-Arumi et al. [24] and Kwok et al. [25] reported a high MH closure rate after one or two surgical procedures (100 % and 90 % respectively), but OCT was not performed. Therefore, the anatomical success rate could have been biased by the difficulty to biomicroscopically analyze the macular region in highly myopic eyes without the use of tomographic images.

When compared to emmetropic eyes, MH closure rates in high myopic patients are usually less satisfactory, even though morphometric parameters seem not to differ so much between these two groups [8]. Since the ILM seems to represent the structure that mostly contributes to the biochemical strength of the retina [33], its removal might decrease the retinal strength, facilitating the retinal elongation. As a consequence, despite an immediate closure of the MH, this relative weakness might eventually predispose more easily to central retinal tears, as demonstrated by the postoperative appearance of non-foveal MH in some cases [38–40]. This could appear even more likely in HM eyes in which the retina is thinner and anteroposterior traction are increased due to the staphyloma. Nevertheless, despite these considerations, several authors observed that preoperative MH configuration, as well as anatomical and functional outcomes, may be similar between HM and emmetropic eyes in some cases [10, 26–28].

Regarding HM-MH closure failure, it seemed to occur more frequently in eyes with a greater axial length, as indicated by Suda et al. [26], who reported a final MH closure rate of 73.3 %, but 100 % of anatomical closure failure in case of axial length of 30.0 mm or more. Thus, the authors suggested that the greater the axial length, the greater the risk of an unsuccessful surgery seems to be, possibly because of the inability of the retina to adapt its relative elasticity to the progressive axial elongation in eyes with high myopia and posterior staphyloma. This may finally prevent the MH closure with an increased risk to develop a posterior retinal detachment.

In summary, when treating HM-MH without foveoschisis, a similar surgical technique as in non-myopic cases, including PPV, ILM peeling and intraocular tamponade with gas or silicone oil, should be effective.

Regarding the "*Schisis Group*", Ikuno et al. [20] reported a lower rate in primary MH closure (12.25 %). Based on this poor anatomical result, they postulated that ILM peeling and gas tamponade do not provide sufficient redundancy to the retina, which might be considered as a limitation of this type of surgery. The rate of hole closure in cases with concomitant FS was considered to be comparable with that of myopic MHs with a retinal detachment. In contrast, as indicated in the comparative study of Jo et al. [10], a flat MH resulted in a favorable anatomical outcome (78 %), which is almost comparable to the surgical results in non-myopic idiopathic cases. This might be explained by a different pathogenic mechanism between MH with and without FS in HM patients.

Myopic FS is believed to be caused by posterior staphyloma growth and consequent inner retinal tension against ocular growth. These causative factors include the presence of a vitreous cortex, epiretinal membranes, vascular stiffness and of an ILM. If the inner retinal tension is sufficiently strong, the retina can split. Many elements could contribute to the development of MH in FS cases, and different patterns of progression have been described [35]. The focal elevation of the external retinal layer and the following development of outer lamellar macular hole probably secondary to the increased inward traction, which is caused by the rigidity of the ILM and inflexibility of the retinal vessel, may be then transferred by the column-like structures within the FS. At a later time, a foveal detachment may enlarge horizontally and elevate vertically, and a full-thickness macular hole (FTMH) may develop after the rupture of the inner retina. Nevertheless, evolution of myopic retinoschisis into a complete MH may also progress through a different path, suggesting an inner layer macular hole (ILMH) as the first step.

The opening of the roof of the retinoschisis or any foveal pseudocyst, if present, may provoke an ILMH. Although myopic retinoschisis beneath the ILMH can remain stable for a long time, or even improve in some cases, the ILMH might finally proceed into a FTMH as long as the remaining external retinal tissue beneath the ILMH continues splitting posteriorly until it reaches retinal epithelium pigment. Beyond the pathogenetic mechanism, however, premacular structures such as partially detached posterior hyaloid and epiretinal membrane, could cause a tangential traction to the fovea and facilitate the development of a MH in myopic eyes with FS, as they do in idiopathic macular hole formation in emmetropic eyes.

Thus, the inner retinal tension associated with FS cannot be eliminated completely by vitreous surgery, since some of the components, that is, vascular stiffness and posterior staphyloma, cannot be removed. The remaining tension prevents MH closure, which is the reason for the poorer anatomical outcome in schisis-type MHs. One reason is that the retina may be too stretched to seal a MH in these eyes with a greater axial length. Inner retinal shortening is a major cause of the development of MF. As consequence, this shortening lifts the inner retina from the outer retina and results in retinal splitting (MF) by producing a radial force directed toward the center of the eyeball. Trying to resolve the foveoschisis with vitreous surgery in schisis-type MHs may enlarge the MH, because the retinal reattachment itself forces the inner retina to follow a larger arc made by the choroid/sclera [20]. Moreover, as indicated in the case-report by Ikuno and Tano [31], HM patients with macular hole and FS that did not close after vitreous surgery seem to be more likely to develop a retinal detachment, which is, on the contrary, very uncommon in emmetropic eyes with persistent MH. In other words, it has been postulated that HM-MH with concomitant foveoschisis seems to represent the stage prior to a retinal detachment secondary to MH [41, 42], and moreover, that progressive axial length or foveal detachment (or both conditions) might interfere with MH closure in these eyes [43]. Nowadays, episcleral macular buckling appears as the only surgical technique that shows both MH closure rates and macular reattachment rates of 80 % or more in cases of MMHRD, which has been definitively recognized as a traction disorder related to high myopia [11, 44–47]. Considering MH with foveoschisis as a further specific myopic staphyloma-related complication, reshaping the posterior scleral wall seems reasonable, and the combination of vitrectomy and ILM peeling to alleviate internal tangential traction with macular buckling, which counteracts the pulling effect caused by the staphyloma, seems to increase the anatomical success rates in these cases, as demonstrated by Burés et al. [21].

In summary, whereas both tangential and anteroposterior tractions contribute to idiopathic MH formation, current reports suggest centrifugal traction as the mechanism of MH formation in myopic FS. Based on this hypothesis, treating MHs with vitrectomy and ILM peeling by releasing the vitreous traction from the fovea is reasonable. However, the surgical results of vitrectomy for MHs associated with FS are generally poor, suggesting the contribution of additional tractional forces due to axial length elongation in high myopia. The reason for poor MH closure is unknown; however, the posterior staphyloma caused by an increasing in the axial length and consequent stretching of the posterior retina specific to highly myopic eyes have been suggested as possible mechanisms. Additional procedures such as episcleral macular buckling, which appears as the only technique that counteracts the anteroposterior traction exerted by the staphyloma, seem to result in more favorable visual outcomes with higher MH closure rates and resolution of foveoschisis, also reducing the risk of retinal detachment secondary to HM-MH in these kinds of patients.

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