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Vitrectomy with fovea-sparing internal limiting membrane (ILM) peeling for myopic foveoschisis

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Abstract

Background
Myopic foveoschisis is a rare form of a tractional maculopathy, which occurs in patients with advanced myopia. The contraction of the posterior hyaloid exerts tangential traction on the retinal surface with a subsequent continuous splitting of the retinal layers. This pathological process can advance inadvertently to severe visual loss and in extreme cases to a macular retinal detachment or macular hole. Surgical therapy of this pathology using vitrectomy with internal limiting membrane peeling is successful, but the thinning of the foveal retina can result during the post-operative phase in a macular hole with subsequent visual loss. We report on a modified surgical technique, which spares the fovea and may reduce the risk for macular hole formation.

Objectives
The aim of this project was to evaluate a novel surgical technique whereby the epiretinal tissue is not peeled over the whole macular area but in a fovea-sparing manner. This means that a small area of the internal limiting membrane overlying the fovea is left in situ which thereby prevents a weakening of the perifoveal tissue and possible macular hole formation in the post-operative phase.

Methods
We observed retrospectively six patients with myopic foveoschisis operated on using this novel technique. The surgical technique comprised a standard 23 gauge pars plana vitrectomy, epiretinal membrane and internal limiting membrane peeling in a fovea-sparing manner and an intraocular gas tamponade using 23% SF6 gas. The role of this tamponade and a face-down position during 5 days was to make sure that the previously dissociated retinal layers will reconnect to the residual normal retina. The macula was examined pre- and post-operatively using optical coherence tomography (OCT) and fundus photography. Post-operative visual acuity recovery and image analysis of the foveoschisis using OCT was evaluated with particular emphasis on the incidence of an early stage macular hole formation. The follow-up of these patients was on average seven months.

Criteria for inclusion :
- High myopia (> -8 Diopters)
- Foveoschisis diagnosed on OCT

Criteria for exclusion :
- Foveoschisis with macular hole
- Previous vitrectomy with entire internal limiting membrane peeling

Results
Mean best-corrected pre-operative visual acuity was 0.87 ± 0.56 logMAR, which increased to 0.60 ± 0.40 logMAR at the end of follow-up. The retinal thickness, as measured by optical coherence tomography, decreased from 799 ± 352 micrometers to 318 ± 60 micrometers at the end of follow-up 7.8 ± 5.7 months. No case developed a macular hole.

Conclusions
Myopic foveoschisis is a rare clinical entity and a randomised clinical trial for the surgical therapy of this pathology will thus unfortunately not be feasible in the future. Clinical management of this disorder will largely depend on clinical experience and low grade evidence case control studies or simple case series. With this caveat we are nevertheless convinced that our research can shed new light on the fovea-sparing internal limiting membrane peeling technique as a promising surgical therapy for foveoschisis, which improves foveal anatomy and retinal function. Due to the sparing of the fovea, this surgical technique may reduce the risk of macular hole formation in the post-operative period.

Introduction

High myopia is one of the most rapidly growing ocular diseases in the last few decades. Most people grow older with a stable myopia, but others will have the axial length of the globe increasing over the years.

Myopic foveoschisis is a rare form of a tractional maculopathy appearing in highly myopic eyes. This pathology has been described recently due to the introduction of optical coherence tomograph (OCT). This device allows ophthalmologists to see the retina in cross sectional way. The images can be compared to biopsies in real time of the retina, providing the ophthalmologist with quasi histological images of all the retinal layers.

The exact pathophysiology of myopic foveoschisis is still unknown but due to its very low prevalence, research into this disease has been characterised by small samples of patients and low grade evidence studies.

An increased axial length, chorioretinal atrophy, vitreomacular traction and an epiretinal membrane are all associated with a higher risk of foveoschisis. (1) as these factors may play a role by stretching the retinal layers away from the sclera. A

posterior staphyloma can also found in association with myopic foveoschisis. (2) This causes distortion of the ocular globe and scleral thinning, chorioretinal atrophy as well as decreased visual acuity. (3) All these risk factors enhance the probability of myopic foveoschisis development but it has been difficult so far to identify which of these factors causes the pathology to occur in the first place.

The evolution of myopic foveoschisis is variable. It can be stable for many years or it can develop into a macular hole formation, a retinal detachment and decreased visual acuity. (4) It has not been explained so far why some patients with myopic foveoschisis stay stable and others don't. As a consequence of this uncertainty, patients need a close follow-up including evaluation of the best-corrected visual acuity, intraocular pressure, a slit-lamp examination and OCT. The outcomes of these tests direct the patient care either towards a clinical follow-up or surgery.

Different surgical techniques have been described, but most of them show macular hole formation as a side effect in a limited amount of cases (13-28%) (5). The most common operation consists in a vitrectomy with peeling of the entire internal limiting membrane. This technique is successful but the thinning of the retinal layers can lead to a macular hole. (6) One risk factor for this evolution is a pre-operative defect in the junction between the inner and the outer segments of the photoreceptors. (7)

Other surgical techniques include vitrectomy and removing only the posterior hyaloid membrane, keeping the internal limiting membrane intact. This surgical technique also ended up with a macular hole formation as a side effect. (8)

The most promising surgical technique todate is fovea-sparing internal limiting membrane peeling. With this novel technique none of their patients developed a macular hole in the post-operative phase, contrary to the patients with the entire limiting membrane peeled off. (9)

The purpose of our research was to evaluate this novel surgical technique whereby the epiretinal tissue was not peeled over the whole macular area but in a fovea-sparing manner.

Methods

We observed six patients with myopic foveoschisis who underwent fovea-sparing internal limiting membrane peeling surgery. All patients had a complete ophthalmologic examination pre and post-operatively, including best-corrected visual acuity, intraocular pressure, a slit-lamp examination, an OCT and fundus photography. Patients with high myopia (> -8 Diopters) and foveoschisis diagnosed on OCT were included in our research, while patients with a macular hole or with previous vitrectomy and entire limiting membrane peeling were excluded. The mean age was 53.8±12.9 years (4M, 2F) and the mean myopia was -18.3±6.5 Dpt. (**Table 1**)

The surgeries were all performed by one surgeon (Prof. Wolfensberger) at the Jules-Gonin Hospital in Lausanne. The surgical technique included a standard 23 gauge transconjonctival pars plana vitrectomy, removal of the residual posterior hyaloid and internal limiting membrane peeling using brilliant blue (DORC, Zuiland, The Netherlands) in a fovea-sparing manner. The internal limiting membrane is grasped with forceps and peeled off in a circular way. (**Figure 1**) At the end of the surgery an intraocular gas tamponade using 23% SF6 gas was administered. The role of this tamponade and a face-down position during 5 days was to make sure that the previously dissociated retinal layers will reconnect to the residual normal retina.

All patients took a postoperative treatment composed by 2x Diamox® 250mg per os to prevent the increase of intraocular pressure, as well as Tobradex® and Scopolamine® drops. Post-operative visual acuity recovery was evaluated using the ETDRS best-corrected visual acuity (BCVA) and we analysed images of the foveoschisis using OCT with particular emphasis on the diagnosis of early stage macular hole formation. For the sake of mathematical analysis of the BCVA ETDRS values were expressed in logMAR units and the very low pre-operative value of „counting fingers" of patient 2 was converted according to Schulze-Bonsel to 1.4 logMAR unit. (10) The follow-up of these patients was on average seven months.

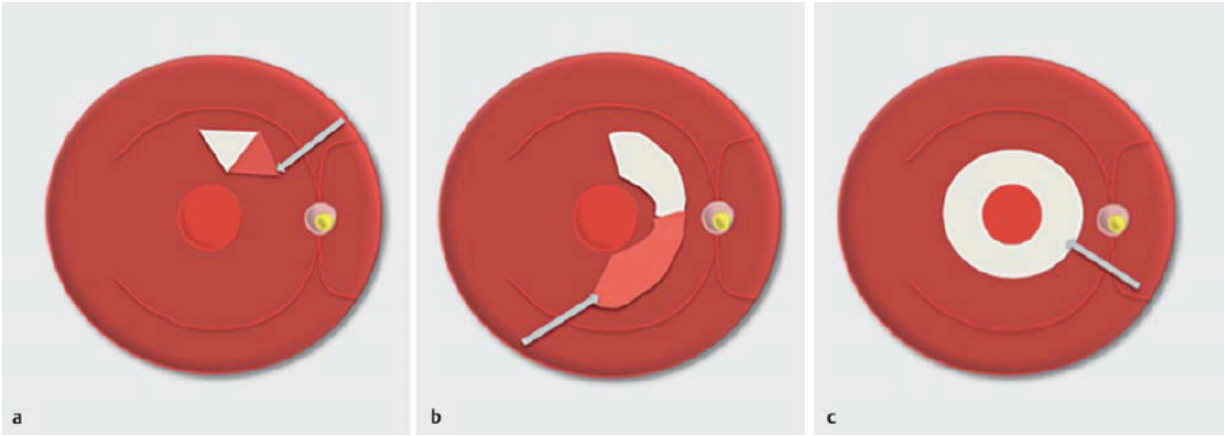

Figure 1. Diagrams of the fovea-sparing ILM peeling (**a**). The ILM peeling begins away from the fovea and continues in a circular manner sparing the fovea (**b**). The ILM peeling is completed over the whole macular surface except for the fovea (**c**).

Table 1. Characteristics of the patients who underwent fovea-sparing internal limiting membrane peeling.

Patient	Gender	Age (ys)	Lens status	Diopters
1	F	63	Phakic	− 16.25
2	M	45	Phakic	− 13.00
3	M	54	Pseudophakic	− 22.00
4	M	60	Pseudophakic	− 27.50
5	M	33	Phakic	− 21.50
6	F	68	Phakic	− 10.00

Table 2. Anatomical and visual outcomes before and after surgery.

Pre-op BCVA	Pre-op logMAR	Final BCVA	Final logMAR	Pre-op CMT	Final CMT
0.16	0.80	0.32	0.50	592.00	315.00
0.01	1.4	0.10	1.00	853.00	412.00
0.80	0.1	1.00	0.00	550.00	296.00
0.05	1.3	0.10	1.00	1475.00	278.00
0.05	1.3	0.16	0.80	562.00	362.00
0.50	0.3	0.63	0.30	759.00	247.00

BCVA = best-corrected visual acuity; IOP = intraocular pressure; CMT = central macular thickness; PMT = peripheral macular thickness; logMAR = logarithm of minimal angle of resolution

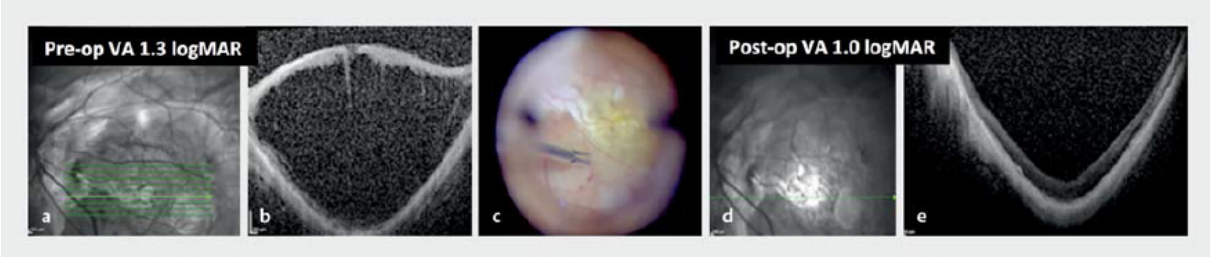

Figure 2. 60 year-old patient with myopic fundus changes in his left eye (**a**). Best-corrected visual acuity was 1.3 logMAR. Pre-operative OCT shows myopic foveoschisis with marked elongated spaces in the outer and inner retina of the

macula (**b**). Intra-operative image of fovea-sparing ILM peeling with endgripping forceps (**c**). Post-operative fundus photograph of the same eye. The best-corrected visual acuity was 1.0 logMAR (**d**). Post-operative OCT showing a completely attached macula with complete attached macula with complete disappearance of the foveoschisis cavity (**e**).

Results

Six patients with highly myopic eyes were included in this study and underwent the fovea-sparing internal limiting membrane peeling. (**Table 1. and Table 2.**) 4 patients were male and 2 were female. The mean pre-operative BCVA was 0.87±0.56 logMAR, which increased to 0.60±0.40 logMAR at the end of the follow-up. **(Figure 3.)** The mean preoperative intraocular pressure was 18.2±2.9 mmHg. The mean postoperative intraocular pressure was 30.2±10.5 mmHg. The mean central macular thickness as measured by OCT decreased from 799±352 µm before the surgery to 318±60 µm at the end of the follow-up. **(Figure 4.)** The mean peripheral macular thickness as measured by optical coherence tomography decreased from 622±37.5 µm before the surgery to 349.33±72.25 µm at the end of the follow-up. None of our cases developed a macular hole. **(Figure 2.)**

Figure 3.

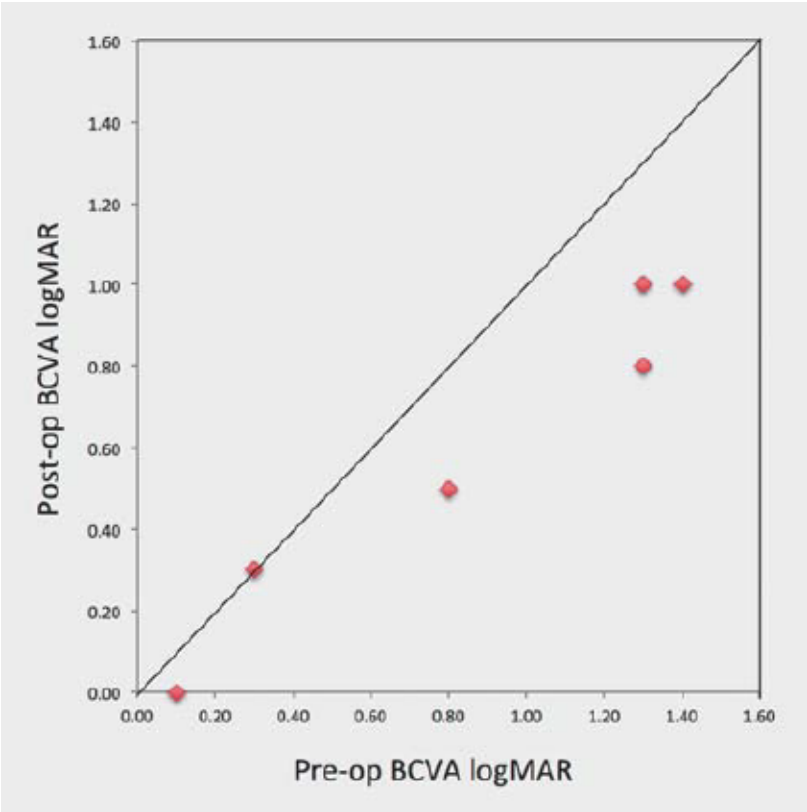

Diagram showing improvement of best-corrected visual acuity (BCVA) in logMAR units in all cases.

Figure 4.

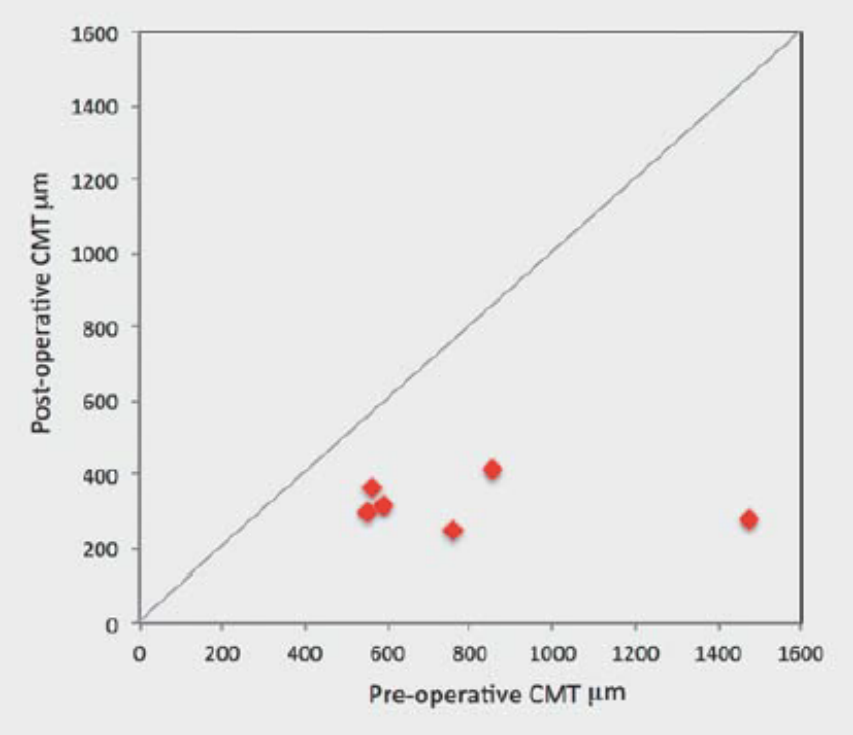

Diagram showing improvement of central macular thickness (CMT) in micrometers as compared by OCT before and after fovea-sparing ILM peeling.

Discussion

Our results show that none of our patients developed a macular hole after they underwent the fovea-sparing ILM peeling surgery during the clinical follow-up. All our patients improved visual acuity and the foveoschisis.

Although this is an observation with important clinical implications, there are some limitations to our study. Using a small sample of patients with foveoschisis we can only report the results of a low-grade evidence study. The mean follow-up was limited to 7.8±5.7 months and it is unknown whether or not the foveoschisis may recur after this period. In a recent publication by Sepulveda, it has been suggested that long-term follow-up of several years may show that foveoschisis eventually recurs in some patients. However, these patients were not operated on by the fovea-sparing technique (11) and it is thus not possible to draw any conclusions concerning the long-term follow-up of patients who had been operated on using this novel technique. Due to the increasing prevalence of highly myopic patients in general, and in Asia in particular, there is a series of recent publications, which have addressed the effect of fovea-sparing ILM peeling for myopic foveoschisis (5, 9, 12,13). All of these studies have confirmed the efficacy of the fovea-sparing technique both on a functional and

anatomical level. More importantly, no macular holes were observed in any of the patients operated on using the fovea-sparing technique.

The only prospective nonrandomized multicentre study for myopic foveoschisis has confirmed a beneficial effect of vitrectomy and ILM peeling with gas tamponade on the reduction of the central macular thickness, although the fovea was not spared during the ILM peeling in these series, and one patient developed a macular hole during the follow-up (14).

Given the paucity of prospective data, the surgical management of myopic foveoschisis will at this stage largely depend on clinical experience. But given the recently published series as well as our observations, we are nevertheless convinced that the fovea-sparing ILM peeling technique is a promising surgical therapy, which improves foveal anatomy and function in advanced myopic foveoschisis with a reduced potential risk for macular hole formation.

In summary, vitrectomy with fovea-sparing ILM peeling and gas tamponade is associated witi better visual and anatomical outcomes and the absence of macular hole formation. Studies with bigger samples of patients and longer follow-ups will be useful to support our results.

Key words: high myopia, myopic foveoschisis, staphyloma, tractional maculopathy

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