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Autologous internal limiting membrane flap for retinal detachment due to posterior retinal tears over choroidal atrophy in highly myopic eyes

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► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/bjophthalmol-2018-313099).

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Received 22 August 2018
Revised 28 September 2018
Accepted 29 September 2018
Published Online First 15 October 2018

To cite: Rossi T, Caporossi T, Rizzo S, *et al*. *Br J Ophthalmol* 2019;**103**:1133–1136.

ABSTRACT

Purpose To review a series of highly myopic eyes with retinal detachment undergoing pars plana vitrectomy with autologous internal limiting membrane (ILM) flap placed over posterior retinal breaks located in areas of choroidal atrophy.

Methods Retrospective review of 13 consecutive patients receiving pars plana vitrectomy with ILM flap over causative breaks, compared with 19 controls receiving the same surgery with ILM peeling but no ILM flap. Main outcome measures included anatomical success rate, visual acuity, number of surgeries and the rate of silicone oil removal.

Results Patients in the ILM group required 2.08±0.37 interventions versus 2.58±0.75 in the control group (p=0.037). One (1/13; 7.6%) patient in the ILM group required additional unplanned surgery versus 8/19 (42.10%) in the control group (p=0.038). Final anatomical success rate defined as attached retina after silicone oil (SiO) removal was 13/13 in the I-ILM group and 14/19 (73.6%) in the control group (p=0.052). No patients (0/13) in the I-ILM group retained SiO at the end of follow-up versus 4/19 (21.1%) patients in the control group (p=0.061). Best-corrected visual acuity at the end of follow-up was logMAR 0.65±0.36 (20/91 Snellen) in the ILM group and logMAR 0.89±0.44 (20/158 Snellen) in the control group (p=0.20).

Conclusion Autologous ILM may help seal posterior retinal breaks and improve the surgical prognosis of retinal detachment due to breaks located over areas of choroidal atrophy within the myopic staphyloma.

INTRODUCTION

Retinal detachment (RD) is a well-known complication of pathological myopia[1] whose surgical treatment can be particularly challenging, especially when retinal tears arise within the staphyloma, over areas of retinal pigment epithelium (RPE) disturbance and/or overt choroidal atrophy.

Proposed treatments include pars plana vitrectomy (PPV) with gas or silicone oil (SiO) tamponade,[2] scleral buckling alone[3 4] or associated to PPV[5] and internal limiting membrane (ILM) peeling with varying success.[6] Regardless of surgical approach, RDs due to posterior tears located over atrophic choroid retain a higher re-detachment rate and dismal prognosis[7] due to the intrinsic re-attachment difficulty and reduced retinal adherence over areas where very little or no RPE and choriocapillaris are present.

Recently, Rizzo *et al*[8] placed autologous ILM over posterior retinal tears arising within the staphyloma and over areas of choroidal atrophy in highly myopic RDs. Kumase *et al*[9] proposed a similar technique for perifoveal macular holes and Okuda *et al* described a single similar case of highly myopic RD associated to macular hole.[10]

The purpose of the present paper is to report a series of highly myopic eyes with RD due to tears located over areas of choroidal atrophy within the staphyloma or around the optic nerve (parapapillary), treated by means of PPV and autologous ILM flap transplantation over the causative retinal tear. In order to evaluate if the use of autologous ILM in terms of prognosis and/or risk of re-detachment, we compared results with the standard of care, represented by PPV, laser treatment and SiO tamponade and ILM peeling alone.

MATERIALS AND METHODS

We retrospectively reviewed the charts of all patients undergoing PPV for RD in highly myopic eyes (more myopic than −9 D) with posterior staphyloma, operated on between 1 May 2015 and 1 November 2017 associated to retinal tears and/or holes within the vascular arcades. We excluded patients with macular holes, incomplete charts and/or follow-up less than 6 months of duration, as well as four patients with multiple tears and three with a giant retinal tear.

Thirty-two patients satisfied inclusion criteria; 13/32 received autologous ILM transplantation over the causative tear in addition to standard vitrectomy (the ILM group) and 19/32 received the same surgery except no ILM was used (control Group).

All patients underwent a standard three-port 23G or 25G PPV, triamcinolone-assisted posterior vitreous detachment induction with meticulous removal of vitreous remnants over the retinal surface, fluid–gas exchange through the posterior break and SiO tamponade (2000 cs polydimethylsiloxane; Micromed, Rome, Italy). Patients in the control group underwent ILM peeling after brilliant blue G staining (Retindyne; Alfa Intes, Italy) while an autologous ILM flap (either hinged or free) was placed over the posterior retinal tear under perfluorocarbon liquid, after retinal reattachment, as elsewhere described[8] (figure 1, online supplementary video 1).

Silicone oil was used as a long-acting tamponade in all cases in order to achieve a faster recovery and

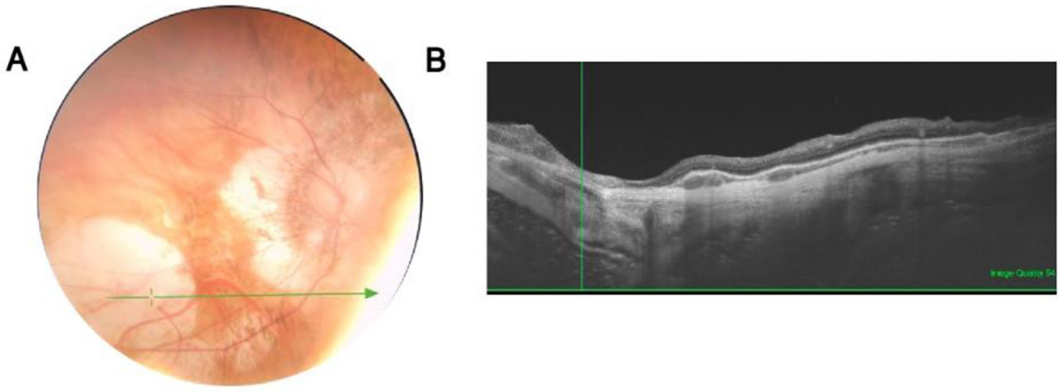

Figure 1 Postoperative retinography (A) and optical coherence tomography (OCT) (B) of patient 11. Green line in (A) shows OCT scan vector. Note that there is no full-thickness retina where autologous internal limiting membrane was placed intraoperatively, corresponding to the retinal pigment epithelium and choroidal atrophy window defect.

also because the sealing of retinal tears overlying areas of patchy choroidal atrophy is lengthy and difficult.

No laser treatment was directly applied around the causative retinal tear overlying choroidal atrophy because the lack of RPE jeopardises the rationale for laser use and increases the risk of overtreatment resulting in iatrogenic retinal tears. Additional prophylactic laser treatment over areas of retinal degeneration was occasionally applied as per the discretional advice of the surgeon.

Outcome measures included visual acuity, attachment rate, number of surgeries and proportion of patients retaining SiO at the end of follow-up.

Statistical analysis used analysis of variance and t-test for continuous variables and χ^2 test or Fisher's exact test for non-parametric ones. P values equal or less than 0.05 have been considered statistically significant.

RESULTS

The two groups did not differ significantly at baseline for age, sex, refraction, axial length and follow-up (table 1). Vision at baseline was similar and extremely low in both groups since the macula was off in all cases.

The chance for a single patient of undergoing additional unplanned surgery (ie, any surgical procedure exceeding original surgery and SiO removal) was 1/13 (7.6%) in the ILM group and 8/19 (42.1%) in the control group (p=0.038). The ILM group underwent and average 2.08±0.37 interventions versus 2.58±0.75 in the control group (table 2; p=0.037).

Initial anatomical success rate intended as attached retina 1 month after SiO removal was achieved in 12/13 (92.3%) patients in the ILM group and 13/19 (68.4%) in the control group (p=0.085). Anatomical success rate at the end of follow-up was 13/13 (100%) in the I-ILM group and 14/19 (73.6%) in the control group (p=0.052).

No patients (0/13) in the ILM group retained SiO at the end of follow-up versus 4/19 (21.1%) patients in the control group (p=0.061).

Best-corrected visual acuity (BCVA) at the end of follow-up was logMAR 0.65±0.36 (20/91 Snellen) in the ILM group and logMAR 0.89±0.44 (20/158 Snellen) in the control group (p=0.20), the difference being not significant.

Table 1 Demographics of control and internal limiting membrane (ILM) groups

	ILM group	Control group	P values
No of patients	13	19	–
Men, women (n, %)	7 (53.8%), 6 (47.2%)	10 (52.6%), 9 (47.4%)	ns
Age (years±SD)	52.9±8.1	55.4±6.2	ns
Axial length (mm)	32.18±2.6	31.09±2.3	ns
Myopic refraction (D±SD)	12.95±2.73	13.34±3.16	ns
Follow-up (months)	13.2±2.92	15.8±4.12	ns

ns, not significant.

DISCUSSION

Degenerative myopia causes profound changes of virtually all ocular structures involved in retinal adhesion. On the subretinal

Table 2 Number of procedures and reason for unplanned re-interventions within the ILM and control groups

	ILM group		Control group	
Patient number	Number of procedures	Reason	Number of procedures	Reason
1	2		2	
2	2		3	Lysis of synechia
3	3	RRD	4	RRD, SiO removal
4	2		2	
5	2		2	
6	2		4	RRD ×2, SiO retained
7	2		4	RRD, SiO removal
8	2		2	SiO retained
9	2		2	
10	2		2	
11	2		2	SiO retained
12	2		3	RRD
13	2		3	ERM peeling
14			2	
15			2	
16			2	
17			3	RRD, SiO retained
18			2	
19			3	ERM peeling
Mean	2.08		2.58	
SD	0.37		0.75	

ERM, epi-retinal membrane; ILM, internal limiting membrane; RRD, recurrent retinal detachment; SiO, silicone oil.

level concur the increased posterior scleral curvature,[11] choroid thinning, choriocapillaris rarefaction and RPE atrophy.[12] Increased vessel[13] and ILM stiffness[14] act from within the retinal structure while anomalous vitreoretinal adhesion and increased vitreous shear stress exert traction on the epiretinal side.

All named factors reduce retinal adherence and help explain why the posterior retina is both more prone to tear and detach and difficult to re-attach in highly myopic eyes.

Among the typical clinical findings of highly myopic RD is the presence of posterior retinal tears located within the staphyloma, often adjacent to retinal vessels or the optic nerve and overlying areas of choroidal atrophy. These breaks pose specific challenges: due to lack of contrast they are difficult to diagnose[15] and harder to repair since physiological adherence mechanism related to RPE function and transretinal fluid dynamics are weaker and retinopexy scarcely efficient, if at all.

As of today, the countermeasures deployed to obtain retinal adherence in such cases aim at altering the scleral contour through scleral buckling[3 4] and/or at increasing tamponade duration using long-term, high-viscosity SiO. Both strategies frequently prove disappointing, falling short of their purpose, since the former is technically difficult and does not apply to peripapillar tears while the latter often only postpones re-detachment. On the other hand, retinopexy frequently adds little or no benefit, lacking its anatomical prerequisite: a healthy or at least viable RPE and choroid.

The rationale for using autologous ILM as a biologic sealant is as follows: whenever RPE and choriocapillaris atrophy compromise active transretinal fluid transportation and mechanisms of intercellular photoreceptor matrix adhesion, glueing or stuffing tissue defects may prevent subretinal fluid infiltration and progressive re-detachment. It seems therefore justified only (or mainly) in a subset of highly myopic RDs with retinal tears located over choroidal atrophy.

In our series of autologous ILM transplantation, we obtained a significantly higher success rate with less surgery than standard of care: only 1/13 (7.6%) patient needed unplanned adjunctive surgery versus 8/19 (42.1%) in the control group and SiO was successfully removed in all patients. This issue deserves further comment since the lack of underlying RPE and choroidal tissue is likely the main reason for re-detachment in highly myopic eyes, when tamponade is removed or gas absorbed. For this very reason, retinal attachment after SiO removal is probably the single more interesting outcome measure for this surgical series.

The ILM fragment may promote retinal tear sealing through a mechanism postulated by De Novelli *et al*[16] for macular holes (MHs) in highly myopic eyes: the tissue acts as a guide for glial cells to slide and gap progressively the entire break span (see figure 1). The role of cryopexy or laser over such areas is negligible if not counterproductive, due to the lack of RPE and choriocapillaris. For these reasons, promoting sealing over the break by using autologous ILM instead of adhesion around it seems a viable alternative and retinal re-detachment rate after SiO removal confirms its value versus the adhesive inflammation process stimulated by the retinopexy, however applied.

The tentative use biologic sealants for retinal tears is a long one and includes several approaches with varying success. First attempts based on liquid adjuvants: blood, platelets[17] and growth factors[18] were applied to MHs and later abandoned because of poor anatomical and functional results. It is possible that intraocular fluid lavage or dilution of biologic adjuvants prevented adequate concentration at wound site and therefore their efficacy.

The use of layered tissue for retinal wound closure started in 2010 when Michalewska described the use of an inverted ILM flap over idiopathic MHs. The technique proved largely successful gaining acceptance and increased indications: larger[19 20] and chronic idiopathic MH, myopic MH[21 22] and, lastly, posterior retinal tears.[23] Other biologic sealants have also been advocated: Chen *et al*[24] placed the crystalline lens anterior capsule over MHs and more recently, full-thickness autologous retina has been used for MHs and retinal detachment.[25] As of today, purported benefits of full-thickness retina compared with other techniques including autologous ILM cannot be established with certainty and the deliberate creation of a retinotomy in myopic retinal detachments is in our opinion bothersome and might worsen prognosis, increasing the risk of PVR and re-detachment.

All the above treatments based on 'solid' sealant (or better biologic layers of different nature) attained better success than previous 'liquid' ones, almost regardless of tissue origin and structure, suggesting the scaffold function is at least as important as their biologic properties, if not prominent.

The ILM flap group showed a trend towards better BCVA at the end of follow-up, although not statistically significant. This result may be underestimated as might be the overall success rate defined as retinal attachment after tamponade removal since a significant proportion of control eyes (some of which previously re-detached), retained tamponade.

In summary, the use of ILM as an autologous sealant for retinal tears located over patchy choroidal atrophy in myopic eyes represents a theoretically sound treatment with interesting preliminary results that appear as a significant step forward when compared with the standard of care.

This study suffers all typical limitations related to retrospective series, including the relatively limited number of cases, lack of randomisation and multiple surgeons. However, the occurrence of RD due to retinal tears located over choroidal atrophy is relatively uncommon and it is therefore difficult to gather larger series. On the other hand, the surgical technique was standardised and the presence of a control group based on previous standard of care of the same surgeons allows meaningful comparison.

Acknowledgements The authors wish to thank the Fondazione Roma for support. The work was completed at Careggi and Policlinico San Martino Hospitals.

Contributors TR: surgeon, designed the study, wrote the manuscript. TC: surgeon, revised the manuscript. SR: surgeon, wrote and revised the manuscipt. CT: analysed data, wrote the manuscipt. ST: analysed data, statistics and revised the manuscript. FB: wrote and revised the manuscript. GR: designed the study and wrote the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent Not required.

Ethics approval IRCCS Ospedale Policlinico San Martino.

Provenance and peer review Not commissioned; externally peer reviewed.

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