·Letter to the Editor·

Scleral imbrication combined with subretinal injection for the treatment of tractional maculopathy in pathological myopia: a case series

Li-Yu Ren[1,2], *Ying Wang*[1,2], *Quan-Hong Han*[1,2]

[1]Tianjin Eye Hospital, Tianjin Key Lab of Ophthalmology and Visual Science, Tianjin 300020, China
[2]Clinical College of Ophthalmology, Tianjin Medical University, Tianjin 300020, China
Correspondence to: Quan-Hong Han. Tianjin Eye Hospital, No.4 Gansu Road, Heping District, Tianjin 300020, China. 5020200063@nankai.edu.cn
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Dear Editor,

Pathological myopia (PM; ≤−6 D) is marked by axial elongation, posterior staphyloma, chorioretinal atrophy and macular degeneration that amplify tangential and anteroposterior traction on the macula. These biomechanical forces predispose patients to myopic traction maculopathy (MTM)—manifesting as macular schisis, traction, or hole-related detachment—thereby threatening central vision and potentially causing irreversible vision loss[1-2]. Conventional treatments often fail to adequately restore the physiological structure and function of the macula. We report a novel combined technique for MTM—pars plana vitrectomy (PPV), subretinal balanced salt solution (BSS) injection, and scleral imbrication (SI).

Ethical Approval The study complied with the Declaration of Helsinki and was approved by the Institutional Review Board of Tianjin Eye Hospital (Approval No.JS-2025004). Written informed consent for publication was obtained from all patients.

CASE PRESENTATION

Case 1 A 58-year-old woman with a history of high myopia presented with progressive decrease in vision and metamorphopsia in the right eye for 1mo. The symptoms had progressed gradually, prompting her to seek medical attention. Preoperative examination revealed a best-corrected visual acuity (BCVA) of 1.30 logMAR (20/400 Snellen), a refractive error of -20.00 D, and an axial length (AL) of 33.14 mm in the right eye. Anterior segment examination revealed a cataract in the right eye. Optical coherence tomography (OCT) demonstrated a full-thickness macular hole measuring 556 μm in diameter, accompanied by a localized area of retinal detachment. The patient underwent 25-gauge three-port PPV combined with phacoemulsification. The technique entailed circumferential internal limiting membrane (ILM) peeling while preserving a circular frill of ILM around the hole; the frill was subsequently trimmed and inverted into the hole with microforceps. Subretinal BSS was injected into the inferior, temporal, and superior quadrants, and SI was performed. At 1mo postoperatively, the AL had decreased to 32.23 mm and further declined to 31.59 mm at the 6-month follow-up. Follow-up OCT confirmed closure of the macular hole and complete retinal reattachment (Figure 1A-1D, Case 1). At 7mo post-surgery, BCVA had improved to 0.70 logMAR (Snellen 20/100).

Case 2 A 56-year-old woman with high myopia presented with one month of visual decline and metamorphopsia in the left eye, with no additional ocular symptoms. Examination revealed BCVA of 1.52 logMAR (20/666 Snellen), a refractive error of -13.00 D, and an AL of 30.54 mm in the left eye. Anterior segment assessment showed nuclear cataract. OCT revealed retinoschisis with epiretinal membrane formation. A 25-gauge three-port PPV was performed. Posterior vitreous detachment was induced intraoperatively, followed by fovea-sparing ILM peeling. Subretinal BSS injections were administered to the inferior, temporal, and superior quadrants, along with SI. Phacoemulsification was subsequently performed 6mo after the initial surgery. At 1mo following the initial surgery, the AL decreased to 29.15 mm. BCVA improved to 1.0 logMAR (20/200 Snellen) at 7mo and further to 0.40 logMAR (20/50 Snellen) at the ten-month visit, with a final AL of 29.83 mm. OCT imaging showed satisfactory resolution of the retinoschisis (Figure 1E-1H, Case 2).

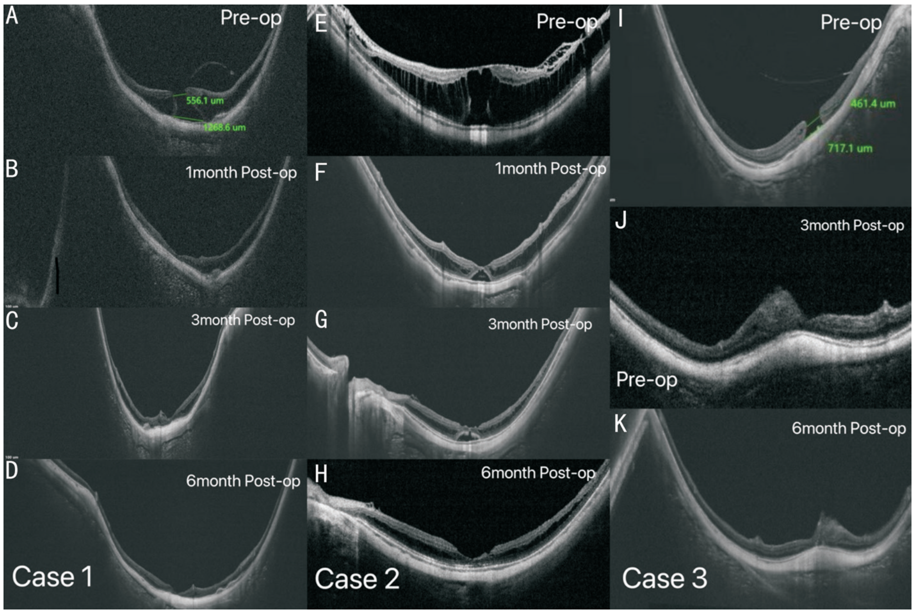

Figure 1 Optical coherence tomography images of three cases Case 1: A: Idiopathic macular hole preoperatively; B–D: At 1, 3, and 6mo postoperatively, the macular hole was completely closed; Case 2: E: Preoperative outer retinoschisis at the macula with foveal retinal detachment; F–H: At 1, 3, and 6mo postoperatively, complete closure was observed; Case 3: I: Idiopathic macular hole preoperatively; J, K: At 3 and 6mo postoperatively, the macular hole was completely closed.

Case 3 A 60-year-old woman with a history of high myopia presented with a 6-month history of decreased vision and metamorphopsia in the right eye. On examination, BCVA was 1.30 logMAR (20/400 Snellen), the refractive error was −24.00 D, and the AL was 33.74 mm in the right eye. OCT revealed a full-thickness macular hole measuring 461.4 μm. The patient underwent 25-gauge three-port PPV. Intraoperatively, posterior vitreous detachment was induced, and an inverted temporal pedicle ILM flap was created. Subretinal BSS injections were administered to the inferior, temporal, and superior quadrants, and SI was performed. At 3mo postoperatively, the AL decreased to 32.58 mm, while BCVA improved to 0.7 logMAR (20/100 Snellen). At the 7-month follow-up, the BCVA improved to 0.7 logMAR (20/100 Snellen). OCT imaging confirmed closure of the macular hole (Figure 1I-1K, Case 3).

Surgical Technique A conjunctival incision was created 1 mm posterior to the limbus, and a 270° temporal peritomy was performed. Tenon's capsule was bluntly and sharply dissected to fully expose the scleral surface. Traction sutures were placed beneath the superior, inferior, and lateral rectus muscles to allow adequate globe rotation. Mattress sutures were preplaced approximately 10 mm from the limbus within the superotemporal and inferotemporal quadrants, maintaining a 3 mm suture spacing and anteroposterior length of 8 mm, to facilitate subsequent scleral buckling imbrication (Figure 2A). A standard 25-gauge three-port PPV with valved cannulas was subsequently performed. The ILM was stained using 0.05% indocyanine green solution. The ILM was then circumferentially peeled with ILM forceps, preserving an ILM flap measuring approximately 1.5 mm×1.5 mm. The flap was inverted and placed over the macular hole, completing the inverted ILM flap procedure (Figure 2B).

The intraocular infusion pressure was reduced to 8–15 mm Hg, and the preplaced scleral sutures were sequentially tightened. During tightening, a strabismus hook was inserted beneath the sutures to indent the sclera, creating inward SI. After switching to the intraocular viewing system, a peripheral scleral fold ridge could be observed (Figure 2C-2D). A 41-gauge subretinal injection needle connected to a syringe filled with BSS was attached to the silicone oil extraction line and set to injection mode with an injection pressure of 20 mm Hg. Subretinal microinjections of BSS were administered at three selected sites located at the inferior, temporal, and superior margins of the posterior staphyloma (Figure 2E-2F). A complete fluid–air exchange was performed. The fluid bubbles were observed to shift toward the periphery of the posterior staphyloma. According to the size of the retinal break and the status of the peripheral retina, either 100% sterile air or 12% C_3F_8 gas was injected into the vitreous cavity to provide adequate tamponade. SI was designed to shorten AL and reduce the curvature of the posterior staphyloma, thereby decreasing anteroposterior traction on the macula and enhancing macular hole closure stability.

DISCUSSION

PM complicated by MTM remains surgically challenging. PPV combined with ILM peeling and tamponade using gas or silicone oil remains a principal intervention in managing

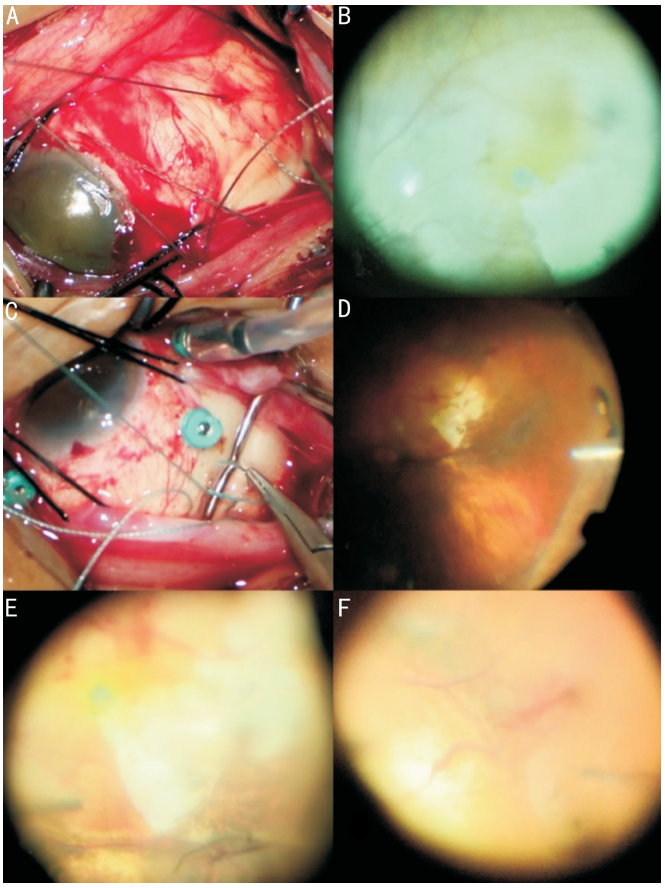

Figure 2 Scleral imbrication combined with subretinal injection for the treatment of full-thickness macular hole A: Scleral tissue was fully exposed, and pre-placed mattress sutures were inserted; B: Following indocyanine green staining, the internal limiting membrane (ILM) was used to plug the macular hole; C-D: A strabismus hook was used to indent the sclera, creating inward scleral imbrication, and a peripheral retinal fold ridge was observed; E-F: Balanced salt solution (BSS) was injected subretinally at the margin of the posterior scleral staphyloma.

MTM[3-4]. However, ILM peeling in highly myopic eyes is complicated by severe chorioretinal atrophy, thinning of the retinal layers, and the presence of posterior staphyloma, which can significantly hinder membrane peeling and heighten surgical risk, culminating in relatively lower rates of macular hole closure and retinal reattachment[5-6]. The tight adherence of subretinal photoreceptors to the retinal pigment epithelium (RPE) at the edge of macular holes impedes the anatomical reapposition of retinal tissue[7]. Achieving successful hole closure relies on the centripetal migration of retinal tissue in conditions where there is an absence of adhesion between the hole margin and the underlying RPE[8].

Oliver and Wojcik[9] first reported the use of subretinal BSS injection for macular detachment in the treatment of persistent idiopathic macular holes. Subretinal injection has subsequently been applied in various vitreoretinal procedures and is considered a feasible and controlled method for transiently separating the neurosensory retina from the underlying RPE[10]. The theoretical rationale of subretinal fluid injection involves BSS entering the subretinal space, which disrupts pathological adhesion between the macular hole edge and RPE, reduces tangential retinal traction, and thereby facilitates approximation and closure of the hole margins. Ye *et al*[11], in a retrospective analysis, demonstrated that posterior scleral contraction (PSC) increased the retinal reattachment rate to 98.6% in 73 highly myopic eyes. They proposed that by limiting abnormal posterior scleral expansion and relieving tangential traction on the macula, the technique promotes spontaneous retinal reattachment and hole closure. de Juan *et al*[12] first described limited macular translocation using a small posterior retinotomy, partial-thickness sclerectomy, and circumferential SI sutures in an effort to minimize complications associated with 360° retinotomy and retinal rotation. Fujikawa *et al*[13] reported that among eight highly myopic eyes with recurrent macular hole retinal detachment after previous vitrectomy, reoperation with "SI, vitrectomy, and sulfur hexafluoride (SF_6) gas tamponade" achieved 100% retinal reattachment and a 75% macular hole closure rate. Baba *et al*[14] observed that in eight highly myopic eyes with retinoschisis without macular hole, surgery involving "SI and vitrectomy (without ILM peeling)" improved visual acuity from 20/100 to 20/50 at 12mo postoperatively, accompanied by a 1.0 mm reduction in AL. External procedures aimed at modifying posterior scleral contour, such as macular buckling or scleral reinforcement, have been increasingly advocated in recent expert consensus as effective strategies to counteract posterior staphyloma-related traction[15]. Recent reports have primarily focused on optimizing intraocular techniques or external scleral procedures separately for highly myopic macular pathology; however, evidence regarding a combined approach that simultaneously integrates vitreoretinal traction release, posterior scleral remodeling, and subretinal interface modulation remains limited[16-17]. MTM is caused by a combination of vertical centrifugal forces and tangential forces acting on the retina. The vertical forces lead to retinoschisis and retinal detachment, while tangential forces contribute to the formation of macular holes[18]. In the region of the posterior staphyloma, the retina is mechanically stretched due to axial elongation. Shortening the scleral structure alleviates traction from vertical forces. The edges of macular holes in highly myopic eyes often adhere tightly to the RPE, making repositioning challenging with conventional vitrectomy techniques. The physical volume of subretinally injected BSS temporarily supports the retina, promotes centripetal expansion of the hole margins, and synergizes with subsequent mechanical traction from gas tamponade or inverted ILM flaps, thereby improving closure rates.

In conclusion, our study demonstrates that the combined surgical approach comprising PPV, subretinal BSS injection, and SI yields favorable functional and anatomical outcomes in three patients with MTM. Compared with conventional single-modality surgical strategies, this combined approach may offer a synergistic therapeutic benefit by simultaneously relieving vitreoretinal traction, modifying posterior scleral configuration, and disrupting pathological adhesion between the macular hole margin and the RPE. The procedure appears to contribute to AL shortening and posterior retinal remodeling, thereby reducing tangential tractional forces and improving macular stability. Moreover, subretinal injection of BSS may facilitate retinal tissue repair and promote macular structural reorganization. This study is limited by the small sample size and short follow-up duration. Collectively, these mechanisms may underlie the favorable anatomical outcomes observed with this technique, although further prospective studies with larger sample sizes are warranted to validate its long-term efficacy and safety.

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