New Surgical Technique for Management of Recurrent Macular Hole
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Abstract:
Recurrence of macular hole (MH) following the standard approach of pars plana vitrectomy, posterior hyaloids removal, internal limiting membrane peeling, gas tamponade, and postoperative positioning is a common postoperative complication following MH surgery. We present a new surgical technique which involves induction of serous macular detachment around the MH, parafoveal retinal massage to bring its edges closer, gas tamponade, and face down positioning. The recurrent MHs had closed in all four consecutive patients with a parallel gain in visual acuity following this technique. All patients had Type 1 closure of the MH indicating its closure without any defect of the neurosensory retina. The MHs remained closed during the follow-up without any late reopening.

Keywords:
Macular detachment, macular hole surgery, recurrent macular hole

Introduction
Macular hole (MH) is a full thickness defect involving the neurosensory retina at the anatomical fovea. Since Kelly and Wendel introduced the technique of pars plana vitrectomy (PPV) with gas tamponade, vitreous surgery has become the standard treatment for MH. At present, the anatomical closure rate of MHs is 90% with vitrectomy and adjuvant therapy of internal limiting membrane peeling (ILMP). However, about 10% of patients, MHs fail to close following this approach.

It has been shown that MH with cuff of subretinal fluid was more likely to close than that without the cuff. It has been also observed that chronic MH has excellent closure rates if passive suction is applied to the edges intraoperatively. We present a new surgical technique which combines these two observations into one surgical procedure to treat the recurrent MH following PPV, ILMP, gas tamponade, and face down positioning.

Materials and Methods
In this study of consecutive case series, patients with recurrent MH following PPV, adequate ILMP of about two disc diameters around the hole and C3F8 (14%) gas tamponade and face down positioning were included. Permission of Institutional Review Board was obtained, and patients signed the informed consent.

The data collected before the new technique included: best correctable Snellen visual acuity, intraocular pressure, fundus photograph, and spectral-domain ocular coherence tomography (OCT by Cirrus, Carl Zeiss, Dublin, USA). The diameter of the MH was calculated in microns on OCT by keeping the calipers on the farthest diametrically opposite edges of MH.

Surgical technique
The first step in the new technique is to create serous macular detachment by injecting balanced salt solution (BSS) under the neurosensory retina with 41-gauge subretinal cannula connected to 1 cc syringe just posterior to the temporal vascular...
arcs at three sites. One puncture each is done two disc diameters above, below, and temporal edge of the MH. BSS is pushed gently under the neurosensory retina to create perifoveal neurosensory detachment around the hole [Figure 1a]. Once the neurosensory blister is created, the detached neurosensory retina is gently massaged toward the center with a diamond dusted scraper avoiding the papillomacular bundle thus converting the round hole into a horizontally oriented transverse slit [Figure 1b]. Then, an end gripping forceps is used to pinch the temporal edges of MH so that its edges get stretched and come closer [Figure 1c and d]. Later, fluid-air-exchange is carried out. Complete drying of the macular area is not the final aim, though. Finally, 14% \text{C}_3\text{F}_8 \text{ gas} is injected. Patients are prescribed face down positioning for 1 week.

Postoperatively, patients were followed up at day 1, 1 week, 2 weeks, every month for 3 months, and at 3-month intervals. Examinations included Snellen visual acuity, anterior segment assessment, intraocular pressure, and clinical evaluation of the posterior segment. OCT examination of the macula was performed once the gas bubble cleared the macular area when the patient was sitting.

**Results**

There were four patients of which three were males and one patient was female. Three (one female and two males) had senile MH, and one male patient had traumatic MH. The primary surgery (i.e., PPV, posterior hyaloid removal, MembraneBlue Dual [DORC International BV, Scheijdelveweg 2, 3214 VN Zuidland, Netherlands] assisted ILMP and 14% \text{C}_3\text{F}_8 \text{ gas tamponade}) was performed for stage 4 MH by the first author with a 25-gauge system. The sizes of recurrent MHs ranged from 658 to 978 microns [Table 1]. The modified re-surgeries were also performed by the same surgeon with 25-gauge system. The pre- and post-operative visual acuity for each patient is mentioned in Table 1.

All patients had Type 1 closure of MH on OCT with significant visual acuity gain (>3 line improvement) postoperatively. The MH remained closed during the follow-up (9–18 months) without any reopening. The pre- and post-operative fundus photos and OCT images of one patient with recurrent MH are shown in Figure 2.

**Discussion**

Currently, the standard technique for MH surgery is PPV, removal of posterior hyaloid, ILMP, gas tamponade, and postoperative positioning. Persistent MH after initial surgery appears in about 10% of cases.\[^2\] Usually, reoperation for a failed MH surgery has a lower success rate than primary surgery. Anatomical closure rate was 88.8% for primary surgery and 46.7% for reoperation.\[^6\]

The exact cause of failure of closure of MH after primary surgery is still uncertain. It may be affected by various factors such as advanced stage of MH, its duration, size, and poor patient compliance with postoperative positioning.\[^1,3,7\] In our case series, all patients had large sized (from 658 to 978 microns) chronic MHs of more than 9 months duration thus explaining the failure following the primary surgery. Reopening of MH after a primary surgery can be managed by enlarging the internal limiting membrane rhexis, additional fluid-gas

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**Figure 1:** (a) The creation of serous macular detachment around the macular hole. (b) The neurosensory retina around the macular hole is being gently massaged toward the macular hole with diamond dusted scraper. (c) An end gripping forceps is used to pinch the temporal edges of macular hole once to stretch the edges of hole to come closer to each other. (d) The round recurrent macular hole now looks like a horizontally oriented transverse slit.

**Figure 2:** (a) Fundus photograph showing recurrent and large traumatic macular hole following primary surgery. Please note the parafoveal retinal pigment epithelial changes. (b) Preoperative ocular coherence tomography image before our modified technique of resurgery. (c) Postoperative fundus photograph following the resurgery. (d) Postoperative ocular coherence tomography image confirming its Type 1 closure.
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exchange, usage of biological agents such as tissue plasminogen activator and resurgery with silicon oil.

The pathogenesis of MH closure primarily involves centripetal movement of retinal tissue to occupy the fovea. Peyman et al. have demonstrated excellent closure rate in chronic holes using passive suction to the edges of the MH.[5] It has also been observed that MH with cuff of subretinal fluid was more likely to close.[3,4] In the case of an MH with a cuff of subretinal fluid, there will not be any adhesion between the MH edges and the underlying retinal pigment epithelium (RPE). With the use of an intraocular tamponade, there is a higher likelihood of closure of such an MH. Conversely, in the case of MH without the cuff of subretinal fluid, its edges are stiff and adherent to the underlying RPE, considerably reducing the chances of hole closure. We combined these two separate concepts into one technique to close the MH which had failed to close following the primary surgery. With this modification, we could achieve Type 1 closure of MH without foveal defect of the neurosensory retina irrespective of its size in 100% of patients with improvement of visual acuity.

Massaging the neurosensory retina with the diamond dusted scrapper is expected to be traumatic to the neural tissue. Initially, we had planned to use soft silicone brush for massaging the retina. However, the surface area of the diamond dusted scrapper is larger as compared to the soft silicon brush thus allowing the least possible number (average 2–4) of massages to the parafoveal retina which converts the round hole into the transverse slit. On the other hand, the small surface area of the soft silicone brush will necessitate more number of massages to achieve the same purpose which can induce more iatrogenic trauma.

In addition, holding the edge of the MH with a forceps and pulling the retina toward center appear to cause additional insult to the neurosensory retina. However, in our technique, the mechanical approximation of the MH was done by application of the forceps to the extreme temporal edge of the MH thus minimizing iatrogenic trauma to the rest of the foveal tissue and the corresponding papillomacular bundle fibers.

To summarize, the new technique essentially involves induction of perifoveal serous detachment around the MH and parafoveal retinal massage to bring the edges of the MH closer. However, this technique needs further evaluation in a larger cohort of similar patients.

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Conflicts of interest
There are no conflicts of interest.

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Table 1: Demographic profile of patients and details of recurrent macular holes

| Gender | Age (years) | Stage; and size of macular hole (μ) | Duration of macular hole | Preoperative VA | Postoperative VA | Postoperative status of macular hole; and pattern of closure | Follow-up period (months) |
|--------|-------------|-------------------------------------|--------------------------|----------------|----------------|-------------------------------------------------------------|--------------------------|
| Female | 54          | 4; 744                              | 12 months               | 20/400         | 20/40          | Closed with Type 1 pattern                                  | 18                       |
| Male   | 74          | 4; 658                              | 9 months                | 20/150         | 20/40          | Closed with Type 1 pattern                                  | 14                       |
| Male   | 32          | 4; 978                              | 5 years                 | 20/400         | 20/70          | Closed with Type 1 pattern                                  | 12                       |
| Male   | 58          | 4; 931                              | 14 months               | 20/200         | 20/50          | Closed with Type 1 pattern                                  | 9                        |

VA: Visual acuity