CASE REPORT

Repositioning of Inverted ILM Flap for Persistent Macular Hole: A Case Report

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ABSTRACT

Purpose: This case report presents the management and outcomes of a persistent macular hole treated using the temporal inverted flap technique, where anatomical closure was not achieved after the initial surgery.

Methods: A 72-year-old male patient presented with a 3-month history of decreased vision in his right eye. Visual acuity in the right eye was 20/200 on the Snellen chart. Fundus examination revealed a macular hole in the right eye. The patient underwent a 25-Gauge pars plana vitrectomy with the temporal inverted flap technique. At the 1-month postoperative OCT evaluation, the flap had properly covered the hole, but the macular hole remained open and the foveal defect persisted. The ILM flap formed a dome-like structure over the hole, with significant fluid accumulation underneath. Three months after the first surgery, a second surgical intervention was planned. The existing flap was folded into its normal position, and the hole was closed again without modifying the flap configuration (flap repositioning).

Results: On postoperative day 12, OCT confirmed that the macular hole had closed and the foveal contour had returned to normal. At the 1-month follow-up, the patient's visual acuity improved to 20/50 on the Snellen chart, and by the 3rd month, it was recorded as 20/40.

Conclusion: This case demonstrates that in macular hole cases treated with the inverted ILM flap technique, repositioning the inverted flap can increase surgical success when anatomical closure is not achieved.

Keywords: macular hole, inverted flap technique, persistent macular hole, vitrectomy, flap repositioning

INTRODUCTION

A macular hole is a vitreoretinal disorder that affects the foveal region and frequently results in significant visual impairment. It has a prevalence of approximately 0.2% in the general population, and the incidence of macular holes requiring surgery is 3.14 per 100,000 people [1]. Macular holes typically develop due to stress and traction exerted by the vitreous on the foveal surface, creating a void in the foveal region. Over time, various surgical techniques have been developed to improve surgical success rates. First described by Kelly and Wendel in 1991, macular hole surgery has undergone significant advancements, including the miniaturization of instruments and innovations in surgical approaches [2]. Two techniques that have notably improved anatomical and functional success rates, particularly in large or complicated macular holes, are internal limiting membrane (ILM) peeling and the inverted ILM flap technique [3].

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Developed by Michalewska et al. in 2009, the inverted ILM flap technique involves mobilizing the perifoveal ILM and inverting it to cover the foveal defect, thereby increasing the rate of anatomical closure [4]. This technique has shown success in large (>400 μm) and highly myopic macular hole cases [5,6]. However, in some cases, despite the ILM flap covering the hole during surgery, anatomical closure may not be achieved postoperatively, requiring further intervention. Related to this situation, a full-thickness macular hole is classified as refractory or persistent when it fails to close following initial surgical intervention, whereas it is termed recurrent if reopening occurs at least four weeks after confirmed anatomical closure [7]. The causes of this condition can include fluid accumulation under the flap, which mechanically prevents closure of the hole edges; flap insufficiency (e.g., insufficient size, misalignment, fibrosis); traumatic manipulation; neurosensory retinal atrophy; or loss of elasticity.

In the management of this condition, the repositioning of the flap and the application of air, gas, or silicone oil tamponades, the reapplication of an ILM flap technique, ILM grafts (e.g., human amniotic membrane), and platelet concentrates (e.g., PRP) or adjuvants (e.g., fibroblast growth factor) have been reported [7,8]. In addition to these methods, subflap fluid aspiration provides a minimally invasive approach that preserves the existing flap and allows its repositioning [9]. Indeed, recent studies have shown that fluid under the flap may delay glial proliferation and closure of the hole [10,11]. Therefore, we believe that this technique can provide very useful clinical results.

This case report presents the management and outcomes of a persistent macular hole treated with the temporal inverted flap technique. In the first surgery, the flap successfully covered the hole, but closure was not achieved. During the second surgery, the flap was repositioned without modification, leading to successful anatomical closure. This highlights the importance of ILM flap positioning in macular hole surgery.

CASE PRESENTATION

Patient Information: A 72-year-old male patient presented with a 3-month history of decreased vision in his right eye. His medical history was unremarkable, and no pathology was found in the other eye upon examination. Visual acuity in the right eye was 20/200 on the Snellen chart.

Fundus Examination and Imaging: Fundus examination revealed a macular hole in the right eye. OCT showed a minimum width of 380 μm and a base width of 620 μm (**Figures 1, 2A**). Axial length was measured at 24.02 mm.

First Surgical Intervention: The patient underwent a standard three-port 25-Gauge pars plana vitrectomy with the temporal inverted flap technique. During the procedure, the Resight wide-angle viewing system was utilized for enhanced visualization, while the Constellation vitrectomy device (Alcon, Fort Worth, TX, USA) was used for vitrectomy. Posterior vitreous detachment was induced, followed by core vitrectomy assisted by triamcinolone injection. The ILM was stained with dual dye, and a free flap edge was created in the temporal region using a scraper spatula. The flap was inverted and positioned over the macular hole in one piece. A 12% C3F8 gas tamponade was used during surgery, and the patient was instructed to maintain a face-down position postoperatively.

After surgery, the patient was advised to adhere to the designated postoperative positioning protocol. Patient was instructed to remain in the prone position for at least 12 hours per day, with an emphasis on avoiding the supine position during the first three days.

Postoperative Evaluation: Macular hole closure patterns were analysed based on MHCP classification according to OCT images [12]: Type 0: open macular hole; Type 1: closed MHs (1A: reconstitution all retinal layers; 1B interruption of the external layers; 1C interruption of internal layers); Type 2: MH closed with autologous or heterologous filling tissue interrupting the normal foveal layered anatomy (2A: filling tissue through all layers; 2B reconstitution of normal inner retinal layers; 2C reconstitution of normal outer retinal layers; 2D H-shaped bridging of filling tissue). At the 1-month postoperative OCT evaluation, the flap had properly covered the hole, but the macular hole remained open and the foveal defect persisted (Type 0 closure). The ILM flap formed a dome-like structure over the hole, with significant fluid accumulation underneath (**Figure 2B**). This suggested that flap positioning and subflap fluid accumulation play a critical role in anatomical closure in macular hole surgery.

Second Surgical Intervention: Three months after the first surgery, a second surgical intervention was planned via 25-gauge pars plana approach. The existing flap was folded into its normal position, and the hole was closed again without modifying the flap configuration (flap repositioning) (**Video 1**). The patient was again placed in a face-down position postoperatively, with a 12% C3F8 gas tamponade used.

Outcomes: On postoperative day 12, OCT confirmed that the macular hole had closed and the foveal contour had returned to normal (Type 1A closure) (**Figure 2C**). At the 1-month follow-up, the patient's visual acuity improved to 20/50 on the Snellen chart, and by the 3rd month, it was recorded as 20/40.

Video 1. In the second surgery, performed 3 months after the first, the flap was repositioned without altering the flap configuration (Link: https://www.retinavitreus.com/uploads/video/Video1-repositioning-of-inverted-ilm-flap.mp4)

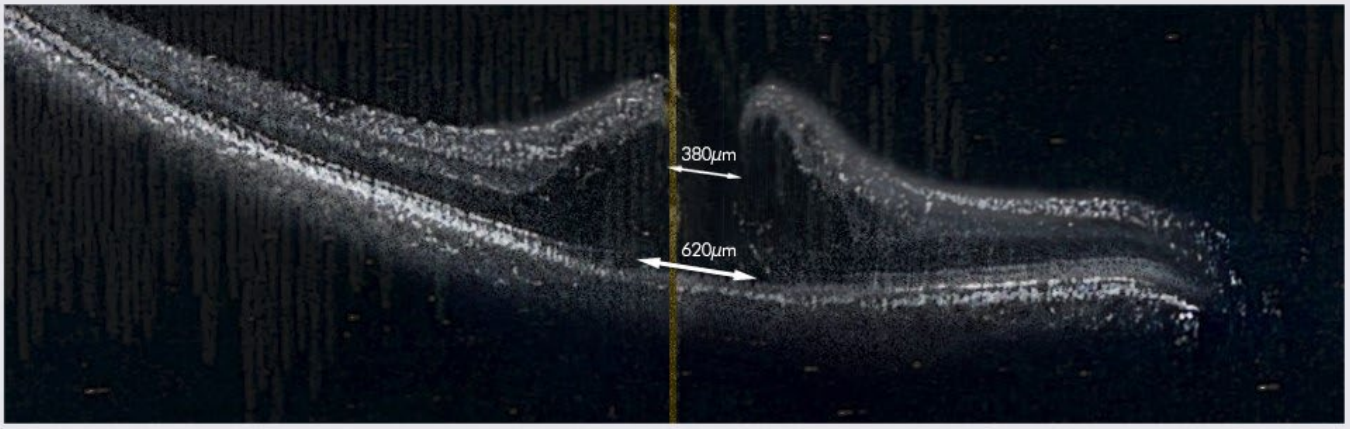

Figure 1. *Preoperative OCT showing a macular hole with a minimum width of 380 µm and a base width of 620 µm.*

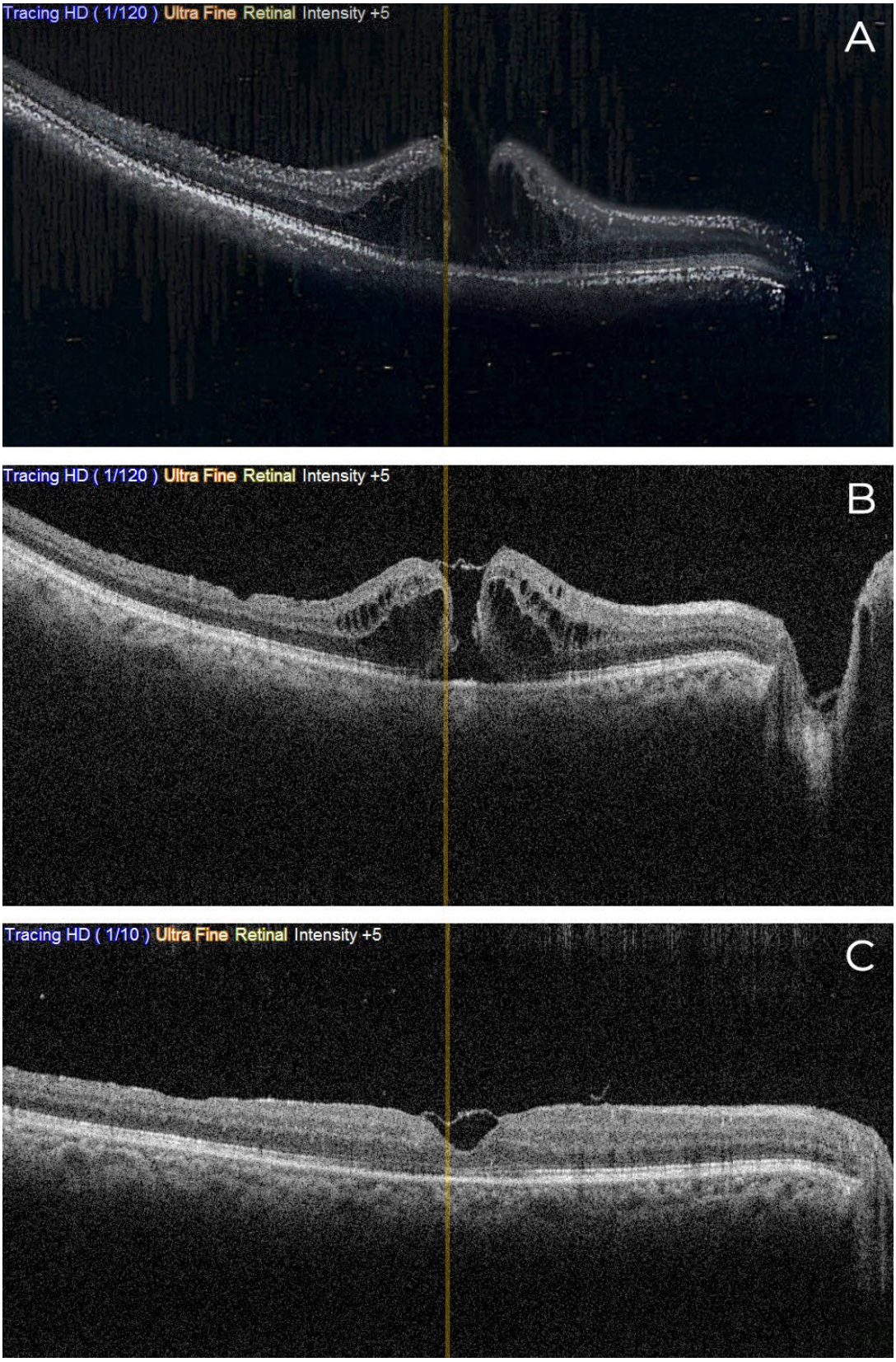

Figure 2. (A) *Preoperative OCT of the macular hole.* **(B)** *Postoperative 1-month OCT showing the unclosed macular hole and persistent foveal defect (Type 0 closure). The ILM flap formed a dome over the hole, with fluid accumulation underneath.* **(C)** *Postoperative day 12 OCT showing a closed macular hole and normalized foveal contour (Type 1A closure).*

DISCUSSION

The inverted ILM flap technique has proven to be an effective method for enhancing anatomical success rates in macular hole surgery, particularly in cases with large (>400 µm) macular holes [5,6]. In a study by Rizzo et al. [13], 620 eyes of 570 patients who underwent surgery for macular holes were examined. Of these, 300 eyes underwent pars plana vitrectomy and ILM peeling, while 320 eyes were treated with the inverted flap technique. The postoperative closure rate for the ILM peeling group was 78.75%, whereas the closure rate in the group treated with the inverted ILM flap was significantly higher at 91.93%. This demonstrates the clear advantage of the inverted flap technique in achieving anatomical success.

Similarly, Baumann et al. [14] found that the macular hole closure rate in patients treated with the ILM flap technique was 98.53%, compared to 87.76% in patients who underwent conventional ILM peeling (P = 0.02). These studies highlight the utility of the inverted flap technique, especially in cases where traditional peeling might not provide adequate closure.

While the exact mechanism behind the closure achieved by the ILM flap technique remains unclear, several hypotheses have been proposed. It is thought that neurotrophic factors secreted by Müller cells play a key role, as do centripetal movements created by the contraction of Müller cell extensions within the outer plexiform layer, as well as the structural support provided by the external limiting membrane surrounding the photoreceptors [15,16]. These elements may help to restore the retinal layers after the flap has been positioned over the hole. However, in some cases, despite the flap's adequate coverage of the hole during surgery, postoperative anatomical closure may not occur [17].

In our case, even though the flap successfully covered the hole following the initial surgery, the presence of fluid under the flap appeared to prevent proper foveal reattachment. The dome-shaped structure formed by the ILM flap and the trapped fluid underneath likely interfered with the hole's closure. This indicates that subflap fluid accumulation can play a critical role in impeding the desired outcome. Similarly, recent studies have shown that fluid under the flap may delay glial proliferation and closure of the hole [10,11]. During the second surgery, the flap was repositioned, allowing the flap to make full contact with the retinal surface. This combined intervention resulted in successful anatomical closure, highlighting the importance of both flap positioning and the elimination of subflap fluid. Multicenter prospective comparative studies are needed to confirm the preliminary evidence.

Michalewska and Nawrocki [18] conducted a study on 32 cases of persistent macular holes following inverted flap surgery. They found that the flap often returned to its original position instead of remaining over the hole, which compromised anatomical closure. In their cases, the repositioning of the flap and the use of air or silicone oil tamponades resulted in successful closure in 89% of eyes after the second surgery and in 100% of eyes after a third intervention. This underscores the importance of revising surgical strategy when initial closure is not achieved, particularly when flap displacement is identified.

In a study by Felfeli et al. [19], hydrodissection was used to treat persistent, chronic (>1 year), and/or large (>400 µm) macular holes. They achieved an anatomical closure rate of 87.2% and reported visual improvement in 94.9% of cases. This surgical technique, which involves the injection of fluid to separate the retina from the underlying retinal pigment epithelium, shows promise in difficult cases where conventional techniques fail. Chen et al. [20] took a different approach by using intravitreal gas injections in patients with early persistent macular holes following vitrectomy. They injected C3F8 gas in 19 eyes of 18 patients and achieved anatomical closure in 63% of cases. Their findings suggested that smaller holes and holes with higher macular hole indices (MHI) had better closure rates. However, despite multiple injections, their success rate was lower compared to techniques such as hydrodissection or flap repositioning.

On the other hand, the situation we described resembles what is described in the literature as a "flap closure pattern," which can be seen in approximately 15-20% of ILM flap cases [21]. It has also been reported that this pattern may close spontaneously within months without the need for any additional intervention [4,22,23]. Therefore, we emphasize that our technique may be particularly useful in cases where the flap closure pattern persists for more than 3-6 months without progressing to anatomic closure. In this context, our technique may be quite effective in suitable cases after failed surgery; however, our results require further validation in larger series.

In light of these findings, we recommend that surgeons carefully evaluate the presence of subflap fluid using OCT when anatomical closure is not achieved. This case demonstrates that in macular hole cases treated with the inverted ILM flap technique, repositioning the inverted flap may increase surgical success when anatomical closure is not achieved. However, we also emphasize that in such cases, the postoperative time for reintervention should be considered, as spontaneous closure may occur in the early postoperative period. Lastly, further clinical studies should be planned to obtain more definitive results and confirm the preliminary evidence in the presented case.

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