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Case Report

Successful Management of Familial Exudative Vitreoretinopathy with a Large Macular Hole Using Inverted Internal Limiting Membrane Flap Technique

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Keywords
Familial exudative vitreoretinopathy · Full-thickness macular hole · Pars plana vitrectomy · Inverted internal limiting membrane flap technique

Abstract
Introduction: This case report aims to shed light on a rare presentation of familial exudative vitreoretinopathy (FEVR) co-existing with a large full-thickness macular hole (FTMH) in a 16-year-old male and discuss its successful surgical management, thereby adding to the limited existing knowledge on this topic. ***Case Presentation:*** Over an 8-month period, the patient had experienced progressively worsening visual blurring and distortion in his left eye. Following a comprehensive examination, diagnosis confirmed FEVR and an accompanying large FTMH. It was hypothesized that this unusual manifestation resulted from the tractional forces exerted by a thick posterior vitreous membrane and a thin epiretinal membrane – a distinctive attribute of FEVR. The patient underwent surgical intervention, which included pars plana vitrectomy (PPV), internal limiting membrane (ILM) peeling, gas tamponade, and the inverted ILM flap technique. Postoperative outcomes were favorable, with the FTMH successfully closed and substantial improvement observed in the patient's visual acuity at the 3-month follow-up visit. ***Conclusion:*** This case report highlights a rare association of FEVR with FTMH, thereby broadening our understanding of potential complications in patients with FEVR. The successful surgical intervention reinforces the utility of the PPV and the inverted ILM flap technique in managing such complications. It underscores the need for clinicians to maintain vigilance for such atypical manifestations in FEVR patients.

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Introduction

Familial exudative vitreoretinopathy (FEVR) is a genetically inherited ocular disorder that impacts the vascular development in the retina [1, 2]. It typically manifests as an avascular zone primarily around the temporal peripheral side of the retina, accompanied by linearization and branching of retinal vessels. A common hallmark of FEVR includes abnormal vessel anastomosis, predominantly at the periphery of this avascular area, triggering exudative changes around the retinal vasculature. Though dragged retina, retinal detachment, and epiretinal membrane (ERM) are frequently observed complications, the occurrence of a full-thickness macular hole (FTMH) in association with FEVR is exceptionally rare, with only a handful of cases documented to our knowledge [3–6]. This report chronicles an unusual case of a 16-year-old male, who presented with an 8-month history of gradually deteriorating vision in his left eye. Subsequent diagnosis confirmed FEVR co-existing with an FTMH. We postulate that the development of the FTMH stemmed from traction induced by a thick posterior vitreous membrane (PVM), a unique attribute of FEVR. This case report augments the limited existing literature on FTMH in the context of FEVR, providing valuable insights into this rare complication and its effective management. The CARE Checklist has been completed by the authors for this case report, attached as supplementary material (for all online suppl. material, see https://doi.org/10.1159/000535714).

Case Report

A 16-year-old male patient was referred to our hospital following an 8-month history of progressively worsening visual blurring and distortion in his left eye. The patient had been previously diagnosed with a macular hole in the left eye at an external clinic and was subsequently sent to our hospital for a comprehensive examination. The patient had no significant past medical history and no known systemic or ocular diseases. There was no relevant medical history reported among his immediate family members, including his parents and younger brother. On presentation, his best-corrected visual acuity was 20/20 in the right eye and 20/200 in the left eye. The intraocular pressure in both eyes was within normal limits, and anterior segment slit-lamp examination disclosed no abnormalities.

Optical coherence tomography of the left eye displayed a large FTMH along with a thickened PVM (Fig. 1). At the level of the minimum linear diameter, the hole measured 649 μm, and at the base, it measured 1,458 μm. Fundus photography of the left eye demonstrated proliferative vitreoretinopathy and linearized retinal vessels, indicative of FEVR (Fig. 2a). Retinal capillary hemangioma was also observed in the lower temporal area (Fig. 2b). Optical coherence tomography angiography and fluorescein angiography of the left eye revealed the presence of linearized retinal vessels and an avascular area accompanied by exudative changes, predominantly located on the temporal side (Fig. 3).

Following the diagnosis of a macular hole secondary to FEVR in the left eye, the patient was deemed suitable for surgical management with pars plana vitrectomy (PPV). Prior to surgery, photocoagulation was performed on the avascular and exudative areas of the retina in the left eye. Following this, a PPV was performed to address the FTMH in the same eye. Cataract surgery was not concurrently performed, taking into account the patient's age. Encircling buckling was not deemed necessary in this case as preoperative photocoagulation was performed on the temporal retina. The surgical procedure entailed initial removal of the core vitreous gel, followed by the excision of the thick PVM from the posterior pole toward the periphery, which exhibited adhesions to the edge of the FTMH. A thin ERM was also identified around the FTMH (Fig. 4a). The inner limiting membranes (ILMs) were

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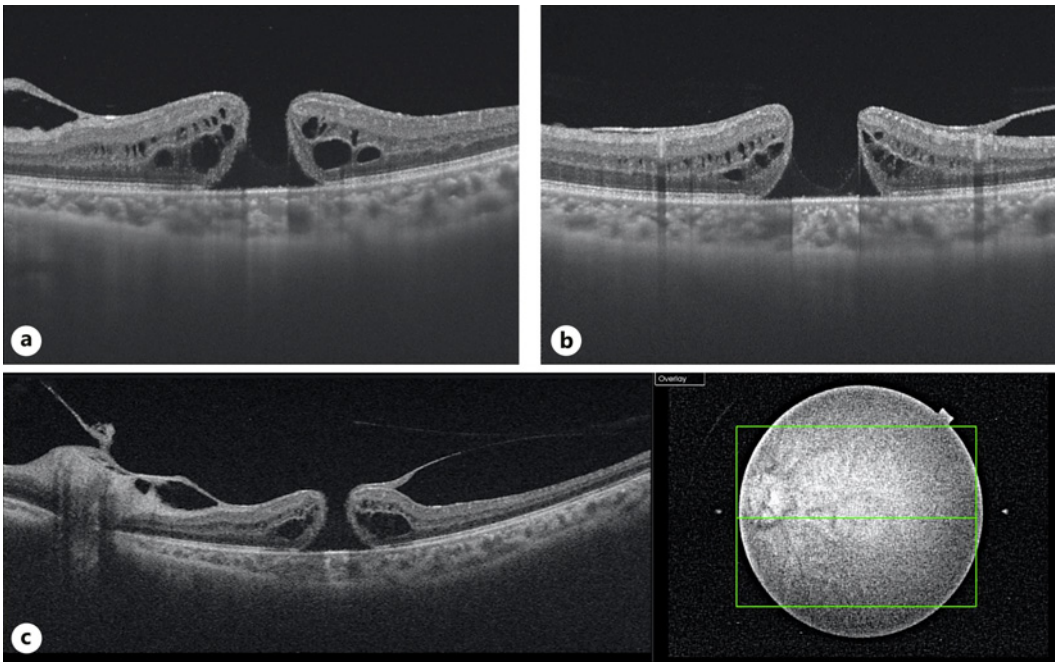

Fig. 1. Preoperative optical coherence tomography (OCT) images of the patient's left eye. **a** and **b** display horizontal and vertical scans, respectively, showing the presence of a full-thickness macular hole (FTMH). **c** depicts a wide-field OCT image, clearly demonstrating the thick posterior vitreous membrane (PVM) attached to the edge of the FTMH and the optic disc.

stained with brilliant blue G and subsequently peeled off along with the ERM. The inverted ILM flap technique was employed (Fig. 4b), succeeded by a fluid-air exchange and a 20% SF6 gas tamponade. The retinal capillary hemangioma in the lower temporal area was coagulated using endodiathermy.

The postoperative course was favorable, with successful closure of the FTMH evident at 1-week follow-up (Fig. 5a and b). At the 3-month postoperative mark, further improvement was observed, with the FTMH remaining closed, and enhanced structural integrity of the external limiting membrane and the ellipsoid zone compared to the 1-week postoperative assessment (Fig. 5c, d). Concurrently, there was a significant improvement in the patient's corrected visual acuity, which upgraded from 20/200 preoperatively to 20/33 at the 3-month follow-up visit. The closure of the macular hole was also confirmed in the ultra-wide field fundus photography 3 months later (Fig. 6).

Discussion

In the case presented herein, we underscore an unusual presentation of a FTMH in a patient diagnosed with FEVR. The traditional clinical features of FEVR include an avascular area primarily forming around the temporal peripheral side of the retina and aberrantly configured retinal vessels [1, 2]. In previous reports, to meet the diagnostic criteria for FEVR, patients have to have all 3 of the following: (1) a lack of peripheral retinal vascular development, (2) birth at full term or premature birth with a progression pattern not consistent with the predictable timeline observed in retinopathy of prematurity, and (3) variable degrees of nonperfusion, vitreoretinal traction, subretinal exudation, or retinal neovascularization occurring at any age [7, 8]. In our case, the patient demonstrated avascularity in the peripheral

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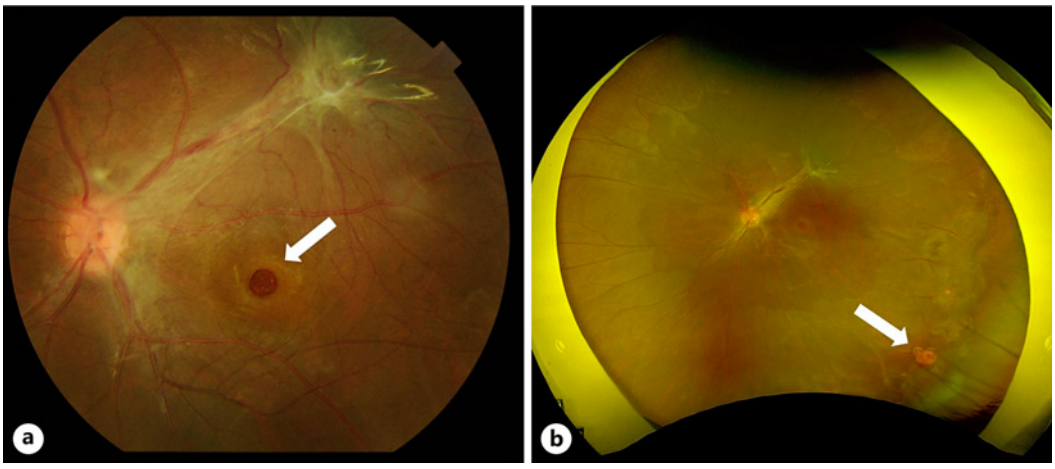

Fig. 2. a Preoperative fundus photography of the left eye, demonstrating FTMH (white arrow), accompanied by proliferative vitreoretinopathy and linearized retinal vessels, indicative of familial exudative vitreoretinopathy (FEVR). **b** Preoperative ultra-wide field fundus photography of the left eye, demonstrating retinal capillary hemangioma in the lower temporal area (white arrow).

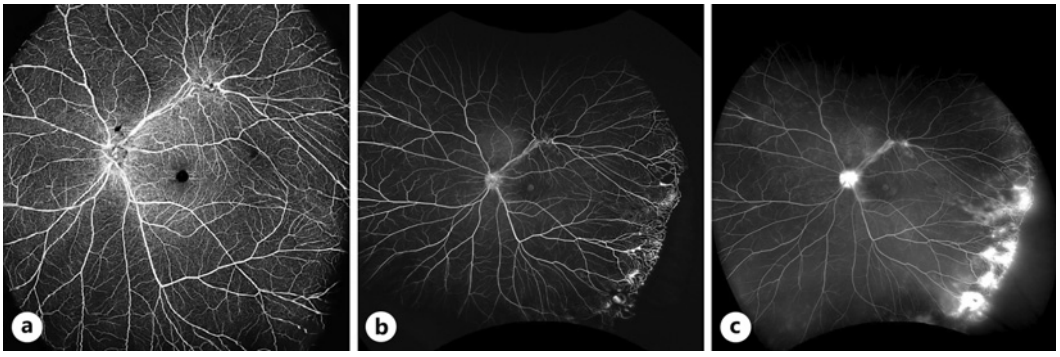

Fig. 3. Preoperative imaging of the left eye, utilizing optical coherence tomography angiography (OCTA; **a**) and fluorescein angiography (FA; **b**: early phase, **c**: late phase), demonstrates linearized retinal vessels, an avascular region, and exudative alterations on the temporal side.

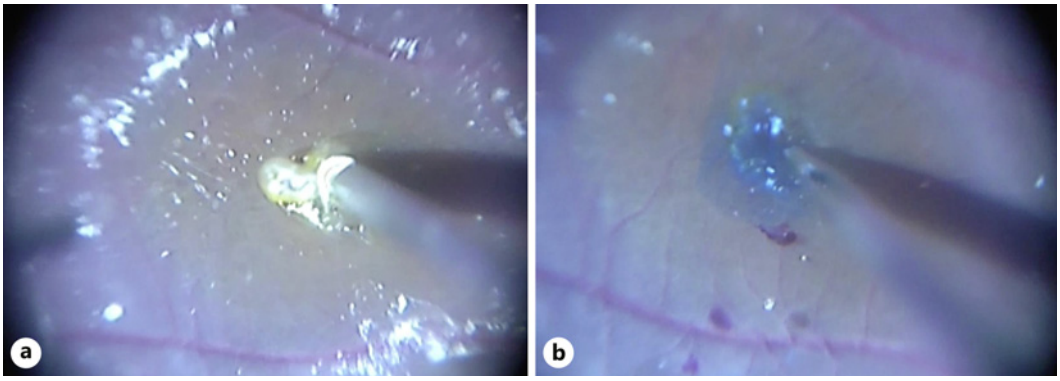

Fig. 4. Intraoperative findings of the patient's left eye. **a** The thick PVM and a thin epiretinal membrane (ERM) around the FTMH was removed. **b** After brilliant blue G staining of the inner limiting membranes (ILMs), we employed the inverted ILM flap technique considering the size of the FTMH.

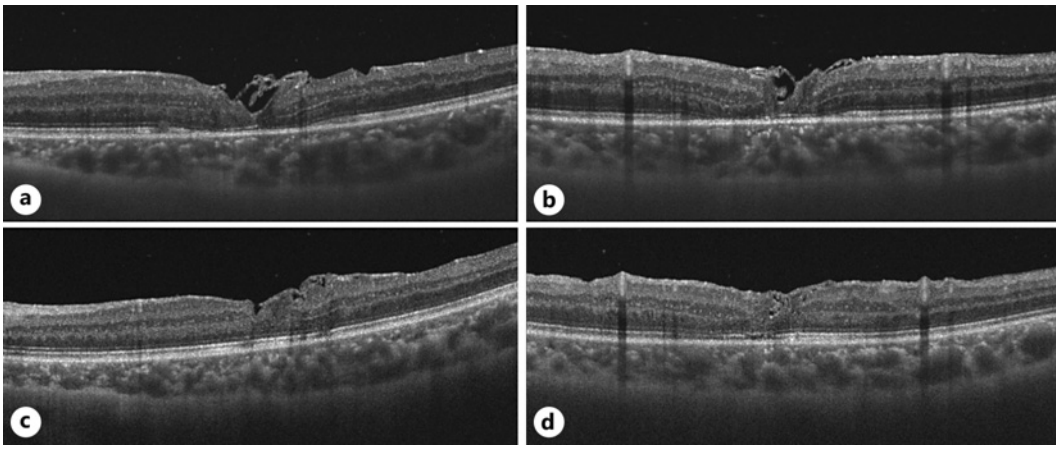

Fig. 5. Postoperative OCT images of the left eye at 1 week and 3 months, demonstrating successful closure of the FTMH. **a**, **b** OCT scans at 1-week postoperative period. The inverted ILM flap is clearly visible. **a** represents a horizontal scan while **b** shows a vertical scan. **c**, **d** OCT scans at 3 months postoperative period. Note the improved structural integrity of the external limiting membrane and the ellipsoid zone compared to the 1-week postoperative images. **c** depicts a horizontal scan and **d** exhibits a vertical scan.

retina (criteria 1), was born at full term with a disease progression inconsistent with retinopathy of prematurity (criteria 2), and exhibited vitreoretinal traction and exudative changes (criteria 3), thereby meeting all the diagnostic criteria for FEVR.

In FEVR, vitreous degeneration is typically more pronounced than in healthy individuals of the same age-group, and a thick PVM often adheres tightly to the retina, extending from the posterior pole to the periphery [2]. These structural alterations in the vitreous can induce ocular complications such as retinal detachment and ERM. Furthermore, in certain instances, localized posterior vitreous detachment (PVD) in FEVR patients can give rise to vitreo-macular traction syndrome [1, 2]. Prior reports have described cases of FEVR in combination with macular disorders, presenting with a narrow vitreo-retinal adhesion in the fovea alongside perifoveal PVD [9]. Although the development of MH or vitreo-macular traction syndrome with such perifoveal PVD in the younger population is typically rare [10], numerous FEVR cases have been complicated by a thick PVM causing substantial vitreo-retinal traction to the macula [1–9]. However, FTMHs accompanying FEVR have been infrequently reported [3–6], making our understanding of this complication limited.

The precise mechanism underlying the formation of an FTMH in FEVR patients remains unclear. A report by Bochicchio et al. [4] highlighted a 28-year-old female, who had thick PVM and lamellar MH that progressed to FTMH following initial vitreous surgery. Another case, presented by Kimura et al. [5], involved a 39-year-old female whose impending MH, generated by the traction of thick PVM, developed into FTMH due to the traction of a thin ERM.

The PVM and the ERM are distinct anatomical structures within the eye, each with different origins and potential pathological implications. The PVM, which forms the innermost layer of the vitreous body, can exert tractional forces on the retina due to its adherence to the retinal surface. Conversely, the ERM is a fibrocellular membrane that forms on the inner surface of the retina, often as a result of proliferative vitreoretinal disorders [11].

In our case, optical coherence tomography image showed the traction of the thick PVM and thin ERM around the fovea was overserved during surgery. Our case suggests that the tractional forces by PVM and ERM may be both contributory.

Our successful intervention with PPV is supported by prior reports that advocate for the effectiveness of vitrectomy in the management of FTMH in FEVR patients [3–6]. PPV with ILM peeling and gas tamponade is common treatment [5, 6]. In our case, given the size of the

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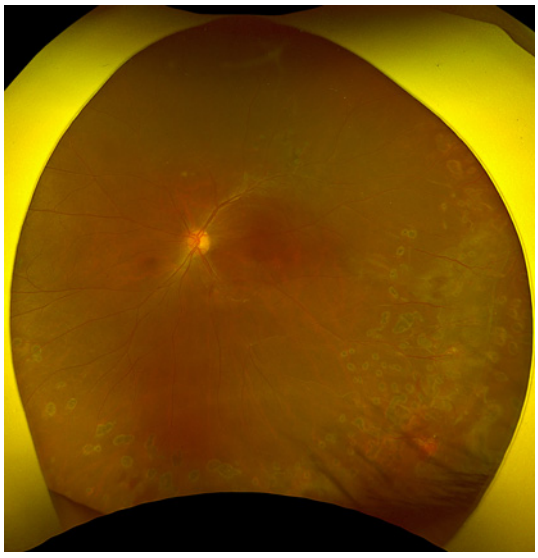

Fig. 6. Ultra-wide field fundus photography of the left eye, 3 months postoperative, demonstrating closed FTMH.

FTMH, we employed the inverted ILM flap technique, a treatment strategy typically reserved for large macular holes [12]. To the best of our knowledge, this is the first report of a case in which inverted ILM flap technique was employed to treat an FTMH caused by the traction of the thick PVM and thin ERM around the fovea in a FEVR patient. This treatment strategy, coupled with diligent post-operative monitoring, proved instrumental in achieving an improved visual outcome for our patient.

Our case report highlights the necessity for additional research to better comprehend the mechanisms underlying FTMH formation in FEVR patients. The efficacy of PPV with inverted ILM flap technique in our case prompts further evaluation of this treatment. Future studies could focus on elucidating the etiopathogenesis of FTMH in FEVR and evaluating the long-term outcomes of the surgical technique employed.

Conclusion

This case report unveils a rare occurrence of FEVR with a large FTMH, hypothesized to arise from tractional forces due to posterior vitreous and ERMs. PPV with an inverted ILM flap technique effectively managed this case. This underscores the need for further research to comprehend such rare complications, refine diagnostics, and optimize treatment in FEVR patients.

Statement of Ethics

This retrospective review of patient data did not require ethical approval in accordance with local/national guidelines. Written informed consent was obtained from the parent of the patient for publication of the details of their medical case and any accompanying images.

Conflict of Interest Statement

The authors have no financial disclosures relating this topic.

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Author Contributions

Masahiro Akada, Toshihiko Nagasawa, and Hitoshi Tabuchi examined and treated the patient. Masahiro Akada, Toshihiko Nagasawa, and Hitoshi Tabuchi contributed to the writing of the manuscript. Hitoshi Tabuchi provided critical manuscript revisions.

Data Availability Statement

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding author.

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