Clinical Outcomes of Endoscope-Assisted Vitreous Surgery for Giant Retinal Tear Detachment

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Keywords

Ophthalmic endoscopy · Giant retinal tear detachment · Vitrectomy

Abstract

Introduction: With the advent of perfluorocarbon liquid (PFCL), the success rate of refractory giant retinal tear (GRT) detachment has dramatically improved. PFCL is a very effective tool when used properly, but in GRT detachment, it may move under the retina through the tear, so it is necessary to devise ways to prevent PFCL from migrating under the retina. Ophthalmic endoscope-assisted vitrectomy may reduce the risk of subretinal migration of PFCL, facilitate safer use of PFCL, and increase the success rate of GRT detachment. The present study aimed to describe the clinical outcomes of endoscope-assisted vitreous surgery for giant retinal detachment. **Methods:** Twenty consecutive eyes from 19 patients who had undergone endoscope-assisted vitreous surgery for treatment of a GRT detachment were enrolled. Subretinal fluid drainage, extension of the rolled GRT, and endophoto-

coagulation under air were performed with the aid of an endoscope, without the use of PFCL. Where necessary, extension of a fixed retinal fold and internal limiting membrane peeling was performed with PFCL. **Results:** The initial and final retinal reattachment rates were 90 and 95%, respectively. In 3 eyes, a small amount of PFCL was used, and there were no PFCL remnants. The mean follow-up duration was 18 months (range, 3–69 months). After surgery, the mean best-correlated visual acuity significantly improved from 20/514 to 20/41 ($p = 0.0008$). **Discussion/Conclusion:** Endoscope-assisted vitreous surgery for giant retinal detachment has favourable clinical outcomes for visual acuity and retinal detachment.

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Introduction

The treatment of a giant retinal tear (GRT) detachment was technically difficult due to the complexity of unfolding the large retinal flap during the surgery, until

Table 1. Baseline patient demographic information

Patient	Age	Sex	Eye	Associated ocular conditions	Lens status	GRT location		GRT size	Macula	Preoperative visual acuity
1	30–35	Male	Left	Atopy	IOL	Temporal	12:00–6:00	180	On	20/20
1	30–35	Male	Right	Atopy	IOL	Inferior	4:00–8:00	120	On	20/20
2	30–35	Male	Right	Trauma	Phakia	Superior	9:00–1:00	120	Off	HM
3	45–50	Male	Left	None	Phakia	Temporal	1:00–4:00	90	Off	20/30
4	30–35	Male	Right	None	Phakia	Temporal	7:30–10:30	90	Off	LP
5	45–50	Male	Right	None	Phakia	Temporal	7:00–11:00	120	Off	HM
6	35–40	Male	Left	Atopy	Phakia	Superior	10:00–3:00	150	On	20/60
7	20–25	Male	Right	None	Phakia	Superior	10:00–4:00	180	On	20/2,000
8	60–65	Male	Left	None	Phakia	Superior	10:00–2:00	120	On	20/25
9	40–45	Male	Left	None	Phakia	Temporal	1:30–4:30	90	Off	20/200
10	50–55	Male	Right	None	Phakia	Superior	11:00–2:00	90	On	CF
11	50–55	Male	Right	None	Phakia	Temporal	7:00–1:00	180	On	CF
12	70–75	Female	Left	Globe rupture	Aphakia	Temporal	2:00–5:00	90	On	LP
13	55–60	Male	Right	None	IOL	Temporal	8:00–11:00	90	Off	20/16
14	20–25	Male	Left	Trauma	Phakia	Superior	9:00–12:00	90	Off	20/16
15	55–60	Male	Right	None	IOL	Inferior	10:00–1:00	90	On	HM
16	35–40	Male	Right	Trauma	Aphakia	Temporal	7:00–11:00	120	On	LP
17	20–25	Male	Left	Trauma	Phakia	Superior	10:00–2:00	120	On	LP
18	15–20	Male	Left	Atopy	Phakia	Nasal	7:00–11:00	120	Off	20/25
19	70–75	Male	Right	None	Phakia	Superior	10:00–1:00	120	Off	20/16

Patient ages are given as a range rather than exact ages to ensure anonymity. GRT, giant retinal tear; IOL, intraocular lens; HM, hand motion; LP, light perception; AKC, atopic keratoconjunctivitis; CF, counting finger.

the advent of perfluorocarbon liquid (PFCL) [1]. Injection of PFCL into the vitreous cavity made it possible to reposition the rolled retina, even if the patient was in a supine position during the surgery, and contributed to a dramatic improvement in surgical outcomes [2, 3]. In recent years, relatively good surgical outcomes for GRT detachment have been reported even in microincision vitreous surgery with the aid of PFCL [4, 5].

However, PFCL sometimes migrates through the retinal break into the subretinal space during surgery, especially in cases with large retinal breaks [2–4, 6, 7]. When PFCL remains in the fovea, its toxicity causes severe vision deterioration [6–8]. There is currently no established method for removing PFCL from under the retina [8]. Therefore, it is desirable to develop a new surgical method for GRT detachment treatment that would minimize the risk of PFCL retention.

We believed that endoscope-assisted pars plana vitrectomy (PPV) could significantly reduce the risk of PFCL retention in GRT detachment surgery. We have previously reported the following advantages of endoscope-assisted vitreous surgery. First, using the endoscope, it is possible to thoroughly drain the subretinal

fluid without the use of PFCL, by turning the patient's head in a position such that the primary retinal breaks are placed at the lowest part of the eyeball [9, 12]. In addition, vitreous surgery under air can suppress the movement of the detached retina using the air-vitreous interface without PFCL [11]. The slipped and rolled retina is stretched out using a silicone-tip backflush needle, by the air surface tension, without PFCL. In this study, we evaluated the surgical outcomes of endoscope-assisted microincision vitrectomy used in the treatment of GRT detachment.

Materials and Methods

Patients

We retrospectively reviewed the data pertaining to 20 consecutive eyes from 19 patients (1 woman and 18 men; average age: 42.8 ± 16.0 years) who underwent 23 or 25G endoscope-assisted PPV for the treatment of GRT detachment at the Japan Community Healthcare Organization Chukyo Hospital from October 2011 to June 2019. The minimum follow-up period was 3 months. The range of baseline best-corrected visual acuity was light perception to 17/20 (Table 1). GRT was defined as a retinal tear extending over 90° .

Fig. 1. Schematic images of endoscope-assisted vitreous surgery for GRT detachment. **a** First, the patient's head was moved toward the position where the GRT was located, at the lowest level. In this position, subretinal fluid can easily flow from the retinal break into the vitreous space. We inserted the backflush needle with a silicone tip from the higher positioned port and the ophthalmic endoscopic probe from the lower positioned port. **b** Then, the rolled retina was unfolded using a backflush needle, under air. **c** Finally, the patient's head was returned to the original position, and endolaser photocoagulation was performed around the primary retinal break, under air. GRT, giant retinal tear.

Surgical Technique

Six surgeons performed all the surgeries. All surgical procedures were performed under topical and regional anaesthesia, using anaesthetic eye drops and sub-Tenon's block. In phakic eyes,

standard phacoemulsification and aspiration was performed in cases where visualization of the patient's fundus was poor due to cataract or there was a risk of progression of the nuclear cataract after surgery. All patients underwent a standard 3-port 23 or 25G

PPV using the Constellation[®] Vision System (Alcon Laboratories, Inc., Fort Worth, TX, USA) or Fortas CV-30000[®] (Nidek Co., Ltd., Aichi, Japan). A noncontact wide fundus viewing system (Resight[®] 700; Carl Zeiss Meditec AG, Jena, Germany) and the imaging system (camera and light source) of an ophthalmic endoscope (FC-304/FL-30127; FiberTech, Tokyo, Japan) were used for visualization. We used an ophthalmic surgery chair (Mepro; Takara Belmont, Osaka, Japan), which can facilitate the change in a patient's position. In all eyes, a core vitrectomy and peripheral vitreous dissection was performed under Resight[®] or endoscope visualization, according to the surgeon's discretion. Then, an endoscope and a backflush needle with a silicone tip were inserted. The patient's head position was turned so that the primary retinal breaks were placed at the lowest part of the eyeball. This was done by adjusting the position of the movable surgical chair and the patient's posture. The subretinal fluid accumulated at the lowest part of the eyeball due to gravity was drained through the primary retinal breaks during the fluid-air exchange (Fig. 1a). The slipped and rolled retina was stretched out as a result of the retinal weight and air surface tension while scraping with a silicone-tip backflush needle under air, without the use of PFCL (Fig. 1b). After the subretinal fluid was sufficiently drained, the patient was returned to the original supine position. Photocoagulation was performed at the edge of the retinal break (Fig. 1c). Then, the entire fundus was inspected under endoscope for any additional retinal tears, which if found were treated with laser. The vitreous dissection around the original tear, subretinal fluid drainage, restoration of the rolled retina, endolaser photocoagulation, and fundus inspection were performed under endoscopic observation in all cases (see online suppl. Video; for all online suppl. material, see www.karger.com/doi/10.1159/000517353). Then, the vitreous cavity was filled with one of the following: air, sulphur hexafluoride (SF6) gas, perfluoropropane (C3F8) gas, or silicone oil (SO) (SILIKON[®] 1000 Oil; Alcon). "The intraocular filling material was determined intraoperatively by the surgeon according to the severity of the retinal detachment." At the end of surgery, the cannulas were removed, and sclerotomies were closed using 8-0 polyglactin 910 sutures (Vicryl[®]; Ethicon, Somerville, NJ, USA), if necessary. The patients were instructed either to maintain a prone position or a position such that the original retinal breaks would be in the uppermost position, for 3–7 days. The SO was removed about 3 months after the initial surgery.

Outcome Measures

Retinal reattachment was evaluated at 3 months after surgery. For the eyes where SO was injected during the vitrectomy, the reattachment was evaluated 3 months after its removal. The outcome measures included anatomical success, visual acuity, and postoperative complications.

Statistical Analyses

The Snellen visual acuity values were converted from decimal to visual acuity values using the Landolt ring chart, and these visual acuity values were then converted to the logarithm of the minimum angle of resolution chart for analysis. Statistical analysis was performed using GraphPad Prism (GraphPad Software, San Diego, CA, USA). The Wilcoxon signed rank test was applied to compare the visual acuity before and after surgery. A $p < 0.05$ was considered to be statistically significant.

Results

Table 1 summarizes the patients' baseline characteristics. The study included 20 eyes from 19 patients (18 men and 1 woman), with a mean age of 42.8 ± 16.0 years (range, 18–74 years). Three patients (patients 1, 6, and 18) had a history of atopic dermatitis, patients 2 and 14 had histories of ocular blunt trauma (they were boxers and had been hurt by a punch to the face during a boxing match and training), and patient 12 had a history of globe rupture prior to the retinal detachment. While she was working on the farm, the gardening pillar was stuck into her eyeball and perforated the sclera. Patient 16 injured his eye with a broken tree branch during logging work.

Patient 17 was injured by an accidental stream of water in his eyes while cleaning the ship with a high-pressure washer hose. The lens status was "phakic" in 14 eyes, "pseudophakic" in 4 eyes, and "aphakic" in 2 eyes. The mean size of the GRT was 119° (range, 90 – 180°). The GRT was located temporally in 9 eyes, superiorly in 8 eyes, inferiorly in 2 eyes, and nasally in 1 eye. The retinal detachment involved the macula in only 9 eyes.

Table 2 summarizes the intraoperative data and postoperative outcomes. During the first surgery, tamponade was performed in 8 eyes using SO (40%), in 6 eyes using SF6 gas (30%), in 5 eyes using air (25%), and in 1 eye using C3F8 gas (5%). Phacoemulsification and aspiration was performed in 8 eyes during the first surgery. In the subsequent surgery, an encircling scleral buckle was placed in 2 eyes (10%). In this study, cryopexy was not performed in either eye; all eyes underwent endolaser photocoagulation. Further vitrectomy was required in 4 eyes (patients 2, 7, 11, and 16) due to retinal re-detachment. With the exception of 1 eye (patient 16) followed up under SO, all the retinas were reattached without any tamponade.

In patient 1, PFCL was used for the purpose of extending the fixed retinal fold; however, the fold did not extend. The retina was stretched out after the air-fluid exchange caused by the surface tension of the air and the stroke of the backflush needle. In patient 2, PFCL was used for fixation of the detached macula to safely perform the inner limiting membrane peeling. In patient 16, PFCL was used to fix the total detached retina and remove the proliferative membrane during reoperation.

Postoperatively, there was no PFCL retained in either of the 3 patients. The SO was later removed in all cases except 1 patient (patient 16). The mean follow-up duration was 18 months (range, 3–69 months), and there was no recurrence of retinal detachment at the last follow-up visit.

Table 2. Intraoperative data and postoperative outcomes

Patient	Sex	Age	Eye	Surgical procedure	Recur- rent RD	Subsequent surgery	PFCL use	SO status	Complications	Final retinal status	Follow- up, mo
1	Male	30–35	Left	23G PPV + SF6	No		No	Out	Microretinal break	Attached	52
1	Male	30–35	Right	23G PPV + PFCL + Air	No		Retinal fold extension	Out	None	Attached	13
2	Male	30–35	Right	23G PPV + C3F8	Yes	PEA + 23G PPV + SO (11 mo), SB (15 mo) postoperatively	ILM peeling	Out	None	Attached	21
3	Male	45–50	Left	23G PPV + SF6	No		No	Out	None	Attached	3
4	Male	30–35	Right	PEA + 23G PPV + SO	No		No	Out	Hypotony	Attached	7
5	Male	45–50	Right	PEA + 23G PPV + Air	No		No	Out	None	Attached	27
6	Male	35–40	Left	PEA + 23G PPV + SF6	No		No	Out	None	Attached	5
7	Male	20–25	Right	PEA + 23G PPV + SO	Yes	23G PPV + PC + SB + SO (4 mo) postoperatively, 23G PP + PC + SO (6 mo) postoperatively, 23G PPV + PC + SO (15 mo) postoperatively	No	Out	Endophthalmitis Microretinal break Bullous keratopathy	Attached	26
8	Male	60–65	Left	PEA + IOL + 25G PPV + SF6	No		No	Out	None	Attached	12
9	Male	40–45	Left	23G PPV + SO	No		No	Out	None	Attached	5
10	Male	50–55	Right	PEA + IOL + 25G PPV + Air	No		No	Out	None	Attached	3
11	Male	50–55	Right	PEA + 23G PPV + SO	Yes	PEA + 23G PPV + SO (1 mo) postoperatively	No	Out	None	Attached	3
12	Female	70–75	Left	Scleral suture + 23G PPV + SO	No		No	Out	None	Attached	18
13	Male	55–60	Right	23G PPV + SF6	No		No	Out	None	Attached	69
14	Male	20–25	Left	23G PPV + Air	No		No	Out	None	Attached	16
15	Male	55–60	Right	23G PPV + IOL + SO	No	23G PPV + SO off + endoPC + SF6 (4 mo), IOL insertion (7 mo) postoperatively	No	Out	None	Attached	11
16	Male	35–40	Right	23G PPV + SO	Yes	23G PPV + SO + PC (2 wk) 23G PPV + SO off + PC + C3F8 (4 mo) 23G PPV + ILM peeling + PC + SO (6 mo) 23G PPV + SO off + PC + C3F8 (13 mo) 23G PPV + PC + SO (15 mo)	Flatten retinal detachment	In	None	Attached (under SO)	20
17	Male	20–25	Left	23G PPV + SO	No	IOL intrascleral fixation	No	Out	None	Attached	16
18	Male	15–20	Left	23G PPV + Air	No		No	Out	None	Attached	21
19	Male	70–75	Right	23G PPV + PEA + SF6	No		No	Out	None	Attached	6

Patient ages are given as a range rather than exact ages to ensure anonymity. RD, retinal detachment; PFCL, perfluorocarbon liquids; SO, silicone oil; PPV, pars plana vitrectomy; SF6, sulphur hexafluoride; C3F8, octafluoropropane; PEA, phacoemulsification and aspiration; SB, scleral buckle; ILM, internal limiting membrane; IOL, intraocular lens.

Anatomical Success

The primary and final anatomical success rates were 90.0% (18/20) and 95% (19/20), respectively.

Visual Acuity

Postoperative visual acuity improved in 16/20 (80%) eyes and remained the same in 3/20 (15%) eyes and 2/20 (10%) deteriorated. The mean best-corrected visual acuity significantly improved from 20/514 preoperatively to 20/41 postoperatively ($p = 0.0008$).

Complications

Retinal breaks occurred in 2 cases. These retinal breaks were small and were closed using photocoagulation. There was 1 (5%) case of postoperative hypotony in this study. In this patient, there was no leakage from the PPV port, and no choroidal detachment was observed. The intraocular pressure spontaneously normalized on the 3rd postoperative day. One patient (5%) had bullous keratopathy after multiple surgeries.

Discussion/Conclusion

During conventional microscopic surgery for GRT detachment, PFCL is injected over the level of the edge of the retinal tears to unfold and flatten the retina [2, 5]. Even if the rolled retina is repositioned under the PFCL, retinal slippage and PFCL migration into the subretinal space sometimes occur during the complicated surgical procedures when PFCL is removed and replaced with a tamponade substance, such as SO [5, 6, 11].

Conversely, in endoscopic vitrectomy, it is possible to tilt the patient's head so that the GRT is located at the lowest point in the eyeball, and complete subretinal fluid drainage can be done under air, without PFCL [9, 12, 13]. We found that, in this position, the rolled retina was easily extended by a gentle stroke of a backflush needle without PFCL. Once the retina was unrolled, retinal slippage did not occur, even if the patient's head was returned to its original position before photocoagulation. Subsequent gas or SO tamponade was performed without any difficulty.

Significant improvement in visual acuity was achieved after the surgery, likely due to the complete retinal reattachment and the rare postoperative complications. The final reattachment rate (95%) in this study is comparable to that reported in previous studies (81.8–100%) [3, 13–17]. However, in one of the patients (patient 11), retinal attachment was not achieved after the initial sur-

gery. This patient had a giant retinal detachment on the temporal side, and 1 month following surgery, an anterior PVR occurred on the nasal side. A thorough peripheral 360° vitrectomy in the initial surgery might have prevented the anterior PVR.

In patient 2, the retina was attached following the initial surgery; however, re-detachment occurred due to a new retinal tear immediately after a head injury during a boxing match. We suspected that the direct ocular trauma caused the re-detachment.

In patient 7, the retina was also attached following the initial surgery; however, several re-detachments occurred during the follow-up period. The reason was not immediately apparent, as the patient did not immediately divulge that he had been scratching the eyes severely after the surgery. Since the provided postoperative eye patch exacerbated the inflammation of the eyelid skin, protective glasses were used instead. Thereafter, the itching gradually disappeared, and there were no further re-detachments.

In patient 16, postoperative hyphema and vitreous haemorrhage were prolonged after the first surgery, and reoperation was performed approximately 2 weeks after the initial surgery to eliminate the vitreous haemorrhage. During the surgery, total retinal detachment was revealed, and after the detached retina was flattened with PFCL, vitrectomy and proliferative membrane resection were performed, and SO was injected. Since the retina was attached under SO for about 4 months, the SO was removed, and the postoperative course was good for 2 months. However, during the outpatient follow-up, there was a gradual proliferative change on the nasal side of the retina, and traction retinal detachment occurred, and reoperation was performed. The proliferative membrane and subretinal fluid in the eye were removed, and SO was injected. Since then, the retina has been attached under SO, and the visual acuity has been maintained. The patient is being followed up without removal of the SO.

Although vitrectomy under air has been reported to be effective in terms of retinal stabilization and identification of the vitreous, visualization of the retina can be severely compromised in certain situations [18, 19]. In that respect, using an endoscope allows for observation in close proximity to the retina, even under air, which means that a detailed visualization is obtained regardless of any difficulties, such as a corneal oedema, small pupil, lens opacity, and limited focus range of the microscope and wide field viewing system. By extending the retina using the surface tension of air, we accu-

rately performed repositioning of the rolled retina and photocoagulation.

There were no cases of retained PFCL after surgery. In patient 1 who had PVR, we used PFCL in a limited area for extension of the fixed retina. Patient 2 had macular detachment at the time of reoperation, and in order to perform inner limiting membrane peeling of the macula more safely, PFCL was injected into the macular arcade to stabilize the detached retina. Since PFCL was not injected to a height exceeding the GRT in both cases, we believe that PFCL did not migrate under the retina.

The major limitations of this research are its retrospective design, and the limited number of cases studied. Moreover, a total of 6 different surgeons performed the surgeries. The intraocular filling material was determined intraoperatively based on the surgeon's judgement, not on clear criteria.

The disadvantages of the endoscope itself are a narrow observation range and low resolution, as well as lack of stereoscopic viewing. For example, it is difficult to perform ILM peeling of the detached macular retina under endoscopic observation, and it may be safer to perform ILM peeling while suppressing the mobility of the retina with PFCL under microscopic observation. In conclusion, our endoscope-assisted vitreous surgery enables favourable retinal reattachment and visual acuity improvement in GRT detachment.

Statement of Ethics

The surgical and experimental protocols were reviewed and approved by the Institutional Review Board of Japan Community Healthcare Organization Chukyo Hospital (#20180399). Written

informed consent was obtained from all participants, and the study conduct adhered to the tenets of the Declaration of Helsinki.

Conflict of Interest Statement

Dr. Kojima reports personal fees from Staar Surgical, personal fees from Santen Pharmaceutical, personal fees from Otsuka Pharmaceutical, personal fees from Johnson & Johnson, and personal fees from Alcon, outside the submitted work. Dr. Ichikawa reports personal fees from Staar Surgical, personal fees from Santen Pharmaceutical, grants and personal fees from HOYA, personal fees from ZEISS, grants and personal fees from Alcon, personal fees from NIDEK, personal fees from KY CenterVue, other from Igaku Shoin, personal fees from Kowa, grants from JFC, personal fees from Novartis Pharma, and grants from MANI, outside the submitted work.

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Author Contributions

All authors met the 4 conditions shown in the ICMJE Criteria for Authorship. Conception or design of the work: H. Mitamura, T. Kaga, T. Kojima, and K. Ichikawa. Data collection: H. Mitamura, T. Kaga, S. Yokoyama, T. Mori, T. Matsuda, H. Sato, and N. Yoshida. Data analysis and interpretation: H. Mitamura and T. Kojima. Drafting the article: H. Mitamura, T. Kaga, S. Yokoyama, T. Kojima, T. Mori, T. Matsuda, H. Sato, and N. Yoshida. Critical revision of the article: T. Kaga, T. Kojima, N. Yoshida, H. Sato, T. Matsuda, S. Yokoyama, and K. Ichikawa. Final approval of the version to be published: H. Mitamura, T. Kaga, T. Kojima, T. Mori, N. Yoshida, H. Sato, T. Matsuda, S. Yokoyama, and K. Ichikawa.

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