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Surgical results of combined pars plana vitrectomy, phacoemulsification, and intraocular lens implantation for various vitreoretinal diseases

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PURPOSE. *To evaluate the results and complications of combined pars plana vitrectomy (PPV), phacoemulsification and aspiration (PEA), and intraocular lens (IOL) implantation.*
METHODS. *A total of 117 eyes from 114 patients who had undergone PPV combined with PEA and IOL implantation were retrospectively analyzed. Combined surgery was performed for a wide variety of vitreoretinal diseases. Intraoperative and postoperative complications were also reviewed.*
RESULTS. *The postoperative BCVA improved by 2 lines or more in 85 eyes (72.6%). Intraoperative complications consisted of retinal tears in 14 eyes (12.0%) and posterior capsular rupture in 2 eyes (1.7%). Iatrogenic retinal tears occurred more frequently in eyes with a macular hole than in eyes with any other disease (p=0.005, chi-square test). Postoperative complications consisted of posterior capsule opacification (PCO) (21 eyes), transient IOP elevation (29 eyes), vitreous hemorrhage (6 eyes), anterior chamber fibrin exudation (11 eyes), posterior iris synechia (8 eyes), neovascular glaucoma (1 eye), and recurrent retinal detachment (RD) (2 eyes). Fibrin exudation occurred more frequently in eyes with proliferative diabetic retinopathy (PDR) and RD than in eyes with any other disease (p=0.03, chi-square test). PCO occurred more frequently in eyes with PDR than in eyes with any other disease (p=0.03, chi-square test).*
CONCLUSIONS. *The present study suggests that a high success rate can be achieved when recently improved PPV techniques are combined with PEA and IOL implantation. The complications that were observed following this combined treatment varied with respect to the vitreoretinal disease present prior to surgery. (Eur J Ophthalmol 2006; 16: 279-86)*

KEY WORDS. *Vitrectomy, Combined surgery, Surgical complications, Triamcinolone, Indocyanine green*

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INTRODUCTION

With the recent advances in vitrectomy and cataract surgery, many previous studies have reported that combined cataract surgery and vitrectomy (CCSV) were safe and effective (1-5). The phacoemulsification and aspiration (PEA) technique can be performed using a brief procedure involving a small incision and therefore it does not significantly increase the total operating time. Some adjuvants such as indocyanine green (ICG) and triamcinolone acetonide (TA) can also make it easier to perform pars plana vitrectomy (PPV) safely. The CCSV technique is required to improve intraoperative visualization of the posterior pole, to safely remove peripheral vitreous, to avoid the need for cataract surgery after vitrectomy, and to allow earlier visual rehabilitation. For these reasons, even if a cataract is not present, CCSVs have been performed on patients with vitreoretinal pathology. In the present study, we retrospectively reviewed 117 patients who had undergone CCSV, and described the surgical results as well as the intraoperative and postoperative complications, according to their respective vitreoretinal pathology.

TABLE I - BASELINE CLINICAL CHARACTERISTICS OF 117 EYES

Variable	Median (range) or n (%)
Age, yr	62.1 (38–80)
Follow-up, mo	19.2 (6–46)
Preoperative visual acuity	0.14 (0.01–1.0)
Sex	
Male	59 (50.4)
Female	58 (49.6)
Diagnostic subgroups	
Retinal detachment	27 (23.1)
Proliferative diabetic retinopathy	26 (22.2)
Macular hole	20 (17.1)
Retinal vein occlusion	16 (13.7)
Epiretinal membrane	11 (9.4)
Diabetic macular edema	8 (6.8)
Retinal macroaneurysm	3 (2.6)
Age-related macular degeneration	2 (1.7)
Terson's syndrome	2 (1.7)
Retinal detachment with macular hole	1 (0.9)
Proliferative vitreoretinopathy	1 (0.9)
Total	117 (100)

TABLE II - MAJOR CAUSES OF DETERIORATION OF FINAL VISUAL ACUITY

Causes	Eye
Subretinal hemorrhage due to ARMD	1
Unclosed macular hole	1
Iatrogenic macular hole	2
Proliferative vitreoretinopathy	1
Branch retinal artery occlusion	1
Total	6

ARMD = Age-related macular degeneration

PATIENTS AND METHODS

From October 1999 to September 2003, 117 consecutive eyes from 114 patients who were undergoing surgery for vitreoretinal pathology were selected for this study. The design of this study was a retrospective consecutive interventional case series. The CCSVs were performed by one surgeon at National Nagasaki Medical Center. The indications for CCSV are listed in Table I and include rhegmatogenous retinal detachment (RD), proliferative diabetic retinopathy (PDR), macular hole (MH), branch retinal vein occlusion, epiretinal membrane of the macula (ERM), diabetic macular edema (DME), and others.

The preoperative and postoperative examinations included a Snellen best-corrected visual acuity (BCVA) measurement, an intraocular pressure (IOP) measurement, a refraction measurement, a corneal endothelial cell count, slit lamp findings, biomicroscopy, and ophthalmoscopy. The keratometry and axial length measurement were performed, and the IOL power was calculated using the SRK-T formula. When impossible, the data were taken from the fellow eye. All patients were observed for at least 6 months. Preoperative and postoperative BCVA were measured in all 117 eyes, which was converted to the logarithm of the minimum angle of resolution (logMAR) scale for statistical analysis. A postoperative IOP value higher than 21 mmHg was defined as an IOP elevation. Corneal erosion that lasted more than 1 week was defined as corneal epithelial dysfunction. The mean difference between predicted and actual refraction in CCSV eyes was compared with the same difference obtained from 89 eyes in which only cataract surgery was performed.

The clinical characteristics of the 117 eyes from 114 patients included in this study are summarized in Table I. Preoperatively, four eyes were treated with antiglaucoma medication for glaucoma (one eye with exfoliation glauco-

ma, one eye with primary open angle glaucoma, one eye with neovascular glaucoma, and one eye with normal tension glaucoma).

Surgical procedure

Cataract extraction preceded vitreoretinal surgery in all cases. A 5.5 or 4.0 mm corneoscleral incision was created at the limbus of the 12 o'clock position. After injecting a viscoelastic substance into the anterior chamber, a 5.0 to 6.0 mm continuous curvilinear capsulorhexis was created with a bent 27-gauge cystotome, and this was followed by phacoemulsification and aspiration. Then a pars plana vitrectomy was performed. After removing the anterior vitreous, the posterior hyaloid membrane was detached. The detachment was extended up to the peripheral retina.

We performed ILM peeling on the MH we encountered, with the aid of ICG at a concentration of 0.05%. In the cases of ERM and PDR, we performed membrane peeling after core vitrectomy. In the cases of RD, we intensively removed the vitreous around the flap of the retinal tear. In 21 eyes, the vitreous gel was removed as much as possible with TA (Kenakolt-A, Bristol Pharmaceuticals KK, Tokyo, Japan). A prior core vitrectomy was performed and 0.5 to 1.0 mL of TA solution was injected into the midvitreous cavity, as previously described (6).

The residual vitreous, which was visualized by means of a TA granule, was removed. The TA of vitreous cavity was washed out as much as possible with suction of the vitreous cutter. The peripheral retina, including sclerotomies ports, was checked with indentation or endoscopy. After the vitrectomy was performed sufficiently, a fluid-air exchange and/or endophotocoagulation were added as required. The fluid-air exchange took place after IOL implantation. A single-piece polymethylmethacrylate (PMMA) IOL with a 5.5 mm optic and 12.5 mm haptic diameter was implanted through a 5.5 mm corneoscleral incision. A foldable acrylic IOL with a 6.0 mm optic and 13.0 mm haptic diameter was implanted through a 4.0 mm corneoscleral incision.

Then the viscoelastic substance was aspirated, the corneoscleral incision was closed with a single 10-0 nylon suture. Then sclerotomies and conjunctiva were sutured with 7-0 Vicryl sutures. At the end of the procedure, subconjunctival gentamicin sulfate (20 mg) and dexamethasone sodium phosphate (4 mg) were administered.

Statistical analysis was performed using the paired t-test, the analysis of variance test, the Bonferroni test, and the chi-square test. The chi-square test was used to analyze the relationships between complication rates and vitreoretinal diseases: RD, PDR, MH, and RVO (n=89).

A p value of 0.05 or less was considered significant.

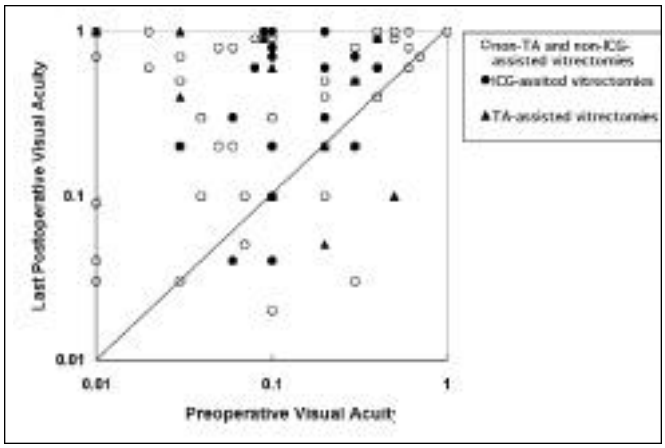

Fig. 1 - *Preoperative and postoperative Snellen visual acuities in 117 eyes. The oblique line indicates the eyes where no change occurred. Open circles indicate 76 eyes that underwent conventional vitrectomy without adjuvant; closed circle, 20 eyes that underwent indocyanine green–assisted vitrectomy; triangle, 21 eyes that underwent triamcinolone acetonide–assisted vitrectomy.*

RESULTS

All patients had phacoemulsification, and 69 of the 117 eyes had a significant cataract. In 115 eyes (98.3%), the IOL was implanted in the capsular bag: 109 PMMA IOL and 8 acrylic IOL were used. In the other 2 eyes (1.7%), PMMA IOL was implanted in front of the capsule because of posterior capsular rupture. A fluid-gas exchange was performed in 61 eyes (52.1%): 6 eyes with air tamponade and 55 eyes with a 20% SF6 gas tamponade. Intraoperative retinal photocoagulation was performed in 75 eyes (64.1%).

A vitrectomy with TA was performed in 21 eyes: 9 eyes with RD, 1 eye with PDR, 2 eyes with MH, 4 eyes with BRVO, 2 eyes with DME, and 3 eyes with other dysfunctions. The correlation between complication rates and TA use was not statistically significant (p=0.096). A vitrectomy using ICG was performed in 20 eyes with MH. In 7 eyes (6.0%), additional surgery was performed for the following complications: an unclosed MH in 2 eyes, a vitreous hemorrhage in 1 eye, a recurrent RD in 2 eyes, a neovascular glaucoma in 1 eye, and a macular pucker in 1 eye.

The mean BCVA improved from 1.44±1.26 (logMAR units; mean ± SD) to 0.46±0.55 (logMAR units; mean ± SD) 6 months after surgery and the difference was statistically significant ($p<0.001$). The last mean BCVA with a mean follow-up period of 19.2±11.2 (mean ± SD) months was 0.38±0.48 (logMAR units; mean ± SD) and there was a significant difference between the preoperative and the last BCVA ($p<0.001$). The last BCVA improved by 2 lines or more in 85 eyes (72.6%), remained unchanged in 26 eyes (22.2%), and worsened in 6 eyes (5.1%) out of a total of 117 eyes.

While the last BCVA worsened in 6 eyes (Tab. II), the causes appeared to be mainly associated with preoperative macular conditions as follows: age-related macular degeneration (ARMD) (a subretinal hemorrhage in the macula due to choroidal neovascularization) (1 eye); an unclosed MH (1 eye); an iatrogenic MH after premacular membranectomy (2 eyes); a proliferative vitreoretinopathy (1eye); or a branch retinal artery occlusion (1 eye).

Refraction was examined 3 months postoperatively. The mean predicted refraction (spherical equivalent) was -1.27±1.11 D. The mean actual refraction was -1.42±1.71 D, and therefore myopia was shifted by 0.16 D from the preoperatively predicted refraction. In our control eyes, on which we only performed cataract surgery, the mean difference between predicted and actual refraction was +0.27D±0.70 D. The refractive error was less than 1.00 D in most patients. In 70 eyes, the corneal endothelium was examined with a specular microscope 3 months postoperatively. The mean endothelial cell densities significantly decreased from 2739±392/mm^2 to 2560±366/mm^2 ($p<0.001$) after surgery.

The mean rate of corneal endothelial cell loss after surgery was 6.5%. Intraoperative and postoperative complications are summarized in Table III.

Intraoperative complications

Iatrogenic retinal tears occurred in 7 (35%) of the 20 eyes with MH, in 4 (15.4%) of the 26 eyes with PDR, and in 3 eyes with other diseases. These tears were successfully treated by the adequate removal of vitreous around the retinal tear, laser photocoagulation, and an air or an SF6 gas tamponade.

No eyes developed RD postoperatively. Iatrogenic retinal tears occurred more frequently in eyes with MH than in eyes with any other disease ($p=0.005$, chi-square test). In addition, an iatrogenic MH occurred in 2 eyes with PDR following a membranectomy. Posterior capsular ruptures during phacoemulsification occurred in 2 eyes: one with PDR and one with ARMD. No eyes developed IOL decentration that required additional surgery.

Early postoperative complications

Eleven eyes (9.4%) – six eyes with PDR, five eyes with RD – developed fibrin exudation in the anterior chamber and were treated with topical corticosteroids, two of which developed posterior synechia. Fibrin exudation occurred more frequently in eyes with PDR and RD than in eyes with any other disease ($p=0.03$, chi-square test). In our study, the postoperative incidences of posterior iris synechia and anterior chamber fibrin exudation were 6.8% and 9.4%, respectively. Captured IOL could be avoided in all by using short-acting dilating drops and subconjunctival injection of dexamethasone sodium phosphate postoperatively. Transient hyphema and vitreous hemorrhage occurred in 1 eye (0.9%) and 4 eyes (3.4%) respectively that disappeared spontaneously. IOP elevation occurred in 29 eyes (24.8%): in 27 out of 29 eyes, IOP was controlled to levels below 21 mmHg with topical antiglaucoma medications and/or systemic carbonic anhydrase inhibitors within 2 weeks. In the other two eyes (involving a silicone oil tamponade and a secondary open angle glaucoma), IOP elevation continued for more than 2 weeks. However, it returned to normal levels within 4 weeks. We performed TA-assisted vitrectomies on 21 eyes (18.0%). In 6 out of 21 eyes, a temporary IOP elevation was observed.

However, it did not last longer than 1 week in any of the eyes. We also performed non-TA-assisted vitrectomies on 96 eyes (82.0%). In 23 (24.0%) of these 96 eyes, a temporary IOP elevation was observed. There is no statistically significant correlation between these two groups ($p=0.657$). In eight eyes, partial posterior synechia of the iris developed. Ten eyes developed corneal epithelium dysfunction that was resolved with topical hyaluronate sodium and ophthalmic ointment.

Long-term complications during follow-up

Postoperative posterior capsular opacification (PCO) requiring capsulotomy occurred in 21 eyes (17.9%, 21 of 109 eyes with PMMA IOL and 0 of 8 eyes with Acryl IOL). PCO occurred more frequently in eyes with PDR than in eyes with any other disease ($p=0.03$, chi-square test). A

YAG laser capsulotomy was performed within 1 to 37 months (mean 17.3 months, SD ±9.7), and BCVA improved in all eyes. Complications were not identified in capsulotomy. Postoperatively, six eyes required additional topical antiglaucoma medications and/or filtering surgery.

One eye with neovascular glaucoma that was present preoperatively required additional panretinal photocoagulation and filtering surgery. Two eyes with exfoliation glaucoma and one eye with silicone oil tamponade required topical antiglaucoma medications. One eye developed new neovascular glaucoma. It was treated with topical antiglaucoma medications and panretinal photocoagulation, and returned to a normal level during the follow-up period. Four eyes (3.4%) developed a vitreous hemorrhage after surgery: one eye needed surgical evacuation; in the other three eyes, their vitreous hemorrhage disappeared spontaneously. In 2 eyes (1.7%), recurrent RD developed: one eye required two injections of sulfur hexafluoride (SF6) gas; the other eye required a silicone oil injection. In 1 eye (0.9%), a branch retinal artery occlusion developed the next day after surgery and postoperative visual acuity decreased. In one eye with ARMD, a subretinal hemorrhage, due to choroidal neovascularization, developed 14 months after surgery.

DISCUSSION

Recently, CCSVs have been thought to be safer, more efficient, and more successful due to improved equipment and the use of adjuvants such as ICG and TA. Previous studies have reported that cataracts tend to progress after PPV (7-9), and will require additional surgery following PPV. In vitrectomized eyes, cataract extraction is difficult and increases the risk of posterior capsule rupture because a decrease in vitreous support causes fluctuations of anterior chamber depth, lens-zonule instability, and excessively mobile posterior capsule (10, 11). CCSV could not only avoid additional cataract surgery but also reduce the medical costs and the stress on patients who would otherwise require additional cataract surgery. CCSV is also preferred for other reasons: to improve intraoperative visualization of the posterior pole and to safely remove the peripheral vitreous. Thus the IOL was inserted at the end of the vitrectomy procedure to avoid light reflexes and the prismatic effects from the lens that might complicate visualization of the peripheral fundus, as previously reported (12).

Intraoperative iatrogenic retinal tears occurred more frequently in eyes with MH than in eyes with any other dis-

TABLE III - DIAGNOSTIC SUBGROUPS AND THEIR INCIDENCE LEVELS AND INTRAOPERATIVE AND POSTOPERATIVE COMPLICATIONS

Complication	RD (n=27)	PDR (n=26)	MH (n=20)	RVO (n=16)	ERM (n=11)	DME (n=8)	Others (n=9)	Total (eyes)
Intraoperative								
Iatrogenic retinal tears		4	7*	1	1		1	14
Posterior capsular rupture		1					1	2
Early postoperative								
Transient IOP elevation	8	7	5	3	2	2	2	29
Fibrin exudation	5*	6*						11
Corneal epithelium dysfunction	1	5	1	1	2	10		
Posterior iris synechia	4	3					1	8
Vitreous hemorrhage	1	4		1				6
Late postoperative								
Posterior capsular opacification	3	9*	1	2	3	3		21
Epiretinal membrane	1	1		2	2			6
Ocular hypertension	1	1		1	2			5
Retinal redetachment	2							2
Vitreous hemorrhage		3		1				4
Neovascular glaucoma						1		1
Branch retinal artery occlusion						1		1

RD = Retinal detachment; PDR = Proliferative diabetic retinopathy; MH = Macular hole; RVO = Retinal vein occlusion; ERM = Epiretinal membrane; DME = Diabetic macular edema; IOP = Intraocular pressure. *p<0.05

ease (p=0.005). These tears were successfully treated in all eyes by the removal of the vitreous around the retinal tear, endolaser retinal photocoagulation, and an air or an SF6 gas tamponade. No eyes developed RD postoperatively.

Although a corneal incision is easier to perform than a corneoscleral incision and it reduces surgery time (13), our CCSV technique was performed with phacoemulsification through corneoscleral incision because of its intraoperative anterior chamber stability (2). Heiligenhaus et al described that both clear corneal and scleral incisions were safe in CCSV. The authors also suggested that scleral incisions were associated with a higher degree of postoperative inflammation than corneal incisions (13). In our study, the postoperative incidences of posterior iris synechia and anterior chamber fibrin exudation were 6.8% and 9.4%, respectively. Iris synechia could be avoided in all but eight eyes by using short-acting dilating drops postoperatively. Previous studies have reported that iris synechia and fibrin exudation occurs in 9–13% (4, 13, 14) and 4–23% (1-4) of eyes, respectively, after PPV. Our incidence level was not higher than the range cited in these previous reports. We were able to use corneoscleral incisions without any serious complications. Fibrin exudation occurred more frequently in eyes with RD and PDR than in eyes with any other disease, and there was statistical significance (p=0.03). Fibrin exudation is also influenced by various other factors, such as cataract surgery, endophotocoagulation, internal tamponade, and diabetes mellitus. The high occurrence level in RD and PDR might be influenced by the total surgery time, endophotocoagulation, and/or internal tamponade.

In our study, corneal endothelial cells decreased in number to 93.5% of the preoperative cell count level. A previous study reported that, following surgery, corneal incisions were more often associated with corneal endothelial dysfunction than scleral incisions (13). In this study of 70 eyes, we compared our results to other studies with regard to the rate of corneal endothelial cell loss. Our results were similar to or better than the results in other reports (15, 16). We therefore believe that it is safe to perform CCSVs through a corneoscleral incision for corneal endothelial cells. Neovascular glaucoma has been described as a severe complication that causes visual loss in patients with PDR after CCSV. Postoperative neovascular glaucoma was controlled in all three eyes (in two eyes it was present preoperatively). We believe this is associated with aggressive preoperative panretinal photocoagulation, intraoperative endophotocoagulation of the anterior retina, and the absence of capsulectomy during surgery in the case of PDR. To reduce the possibility of neovascular glaucoma in diabetic eyes, previous studies have reported that it plays a role in the retention of an intact posterior capsule (9).

PCO that required a capsulotomy occurred postoperatively in 21 of 117 eyes (21 of 109 eyes with PMMA IOL and 0 of 8 eyes with acrylic IOL). The PCO rate was 19.3% for PMMA and 0% for acrylic IOL. Previous studies have reported that the YAG capsulotomy rate was 20–33% for PMMA IOLs (3, 4, 14, 17). Jun et al performed a central posterior capsulectomy after IOL implantation to prevent postoperative PCO (18). However, we did not perform a capsulectomy during CCSV to prevent any possible complications, and in all required cases we could perform the YAG capsulotomy after surgery without any complications. The incidence rate of PCO was significantly higher in eyes with PDR than in eyes with any other disease (p=0.03). Lahey et al described that PCO is probably the result of increased inflammation from the combined surgery along with gas bubble contact with the posterior capsule (19). However, PCO developed in PDR eyes in the absence of a gas tamponade. Previous studies have shown that aqueous flares caused by impairment of the blood-aqueous barrier are more prevalent in eyes with diabetic retinopathy (20). Pre-existing breakdown of blood-aqueous barrier in PDR might be a factor influencing a strong postoperative inflammation that leads to PCO.

The most frequent postoperative complication turned out to be a transient postoperative IOP elevation in 24.8% of the eyes. All but two eyes were controlled within 3 to 6 days with or without antiglaucoma treatment. In the other two eyes, IOP levels were controlled within 4 weeks with topical antiglaucoma medications. We performed a vitrectomy using TA on 21 eyes for the purpose of removing peripheral vitreous and/or confirming the residual vitreous. In 6 out of the 21 eyes, a temporary IOP elevation was observed, but it did not last longer than 1 week in any of the eyes. TA has been reported to cause elevated IOP (21). One dose of TA (4 mg) was injected into the vitreous cavity in several doses in 21 eyes as an adjuvant, and was immediately washed out of the vitreous cavity with balanced salt solution following each of these injections. We performed TA-assisted vitrectomies on 21 eyes (18.0%) and we observed a temporary IOP elevation in 6 (28.6%) of these eyes. We also performed non-TA-assisted vitrectomies on 96 eyes (82.0%) and we observed a

temporary IOP elevation in 23 (24.0%) of these eyes. There is no statistically significant correlation between these two groups (p=0.657; chi-square test). Therefore, we speculate that the amount of residual TA did not influence the postoperative IOP.

ICG dye is useful because it allows for easy detection of the ILM layer; however, ICG's safety has come into question recently. Enaida et al reported that even at a low dose (0.025 mg/mL=0.0025%), intravitreous ICG induced functional damage of the retina without any apparent morphologic damage (22); recently, we perform ILM peeling utilizing TA.

In conclusion, combined cataract surgery and vitrectomy is useful for the treatment of vitreoretinal diseases. The surgical results of combined surgery with the use of recent adjuvants showed that visual outcomes were generally desirable and complications were acceptable. However, eye surgeons have to be careful when they select combined surgery because it is impossible to eliminate the possibility of complications.

This study does not have commercial or proprietary interest.

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