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Macular Hole Surgery with Internal Limiting Membrane Removal, Air Tamponade, and 1-Day Prone Positioning

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Purpose: The internal limiting membrane (ILM) removal has been combined with macular hole surgery in recent years, which facilitates shortening of the prone-positioning period after surgery. In this study, surgical outcome of macular hole surgery with ILM removal, air tamponade, and 1-day prone positioning was evaluated.

Methods: In a prospective study, 23 patients (23 eyes) underwent vitrectomy for idiopathic macular holes. Macular holes <0.4 disc diameter and without apparent atrophy of retinal pigment epithelium (RPE) were selected for study. After vitrectomy combined with the ILM removal and fluid-air exchange, patients were instructed to keep prone positioning for only 1 day. The initial hole-closure rate, complications and visual outcome were evaluated.

Results: Anatomical closure of macular holes was achieved in 21 (91.3%) of the 23 eyes by one operation. The postoperative visual acuity of 0.5 or better and 1.0 were achieved in 19 eyes (82.6%) and 6 eyes (26.1%), respectively. Postoperatively, intraocular pressure was elevated temporarily in 2 eyes (8.7%); retinal break and posterior synechia occurred in 1 eye (4.3%) each. These complications were treated successfully and did not threaten visual acuity.

Conclusion: Air tamponade with ILM removal followed by 1-day prone positioning was considered to be a useful method for macular holes with small diameter and without apparent atrophy of RPE. This method facilitated early recovery to a normal social life. **Jpn J Ophthalmol 2003;47:503–506** © 2003 Japanese Ophthalmological Society

Key Words: Air tamponade, internal limiting membrane removal, macular hole surgery, 1-day prone positioning.

Introduction

Long-acting gas such as C_3F_8 or SF_6 is used for gas tamponade in vitreous surgery for idiopathic full-thickness macular holes.[1–4] As long-acting intraocular gas takes several weeks to disappear, patients are aware of the presence of gas bubbles as black shadows, and some complain that these shadows are obstacles to daily activities.

The internal limiting membrane (ILM) removal has been combined with macular hole surgery in recent years, which facilitates improvement of the hole-closure rate and shortening of the prone-positioning period.[5,6] We also reported a successful surgical outcome after reducing the duration of postoperative prone positioning from 1 week to 1 day, using 11% C_3F_8 as gas tamponade.[7] Following our success in shortening the duration of postoperative face-down positioning, we planned this prospective study using air as the tamponade material. In the present study, the patients with small macular holes and without apparent atrophy of retinal pigment epithelium (RPE) were treated with vitrectomy combined with the ILM removal and fluid–air exchange. Patients were instructed to keep prone positioning for only 1 day. The initial hole-closure rate, complications, and visual outcome were evaluated.

Materials and Methods

This study consists of a prospective series of 23 consecutive cases (23 eyes). Among the patients who underwent

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macular hole surgery between November 2000 and June 2001, those patients with macular holes smaller than 0.4 disc diameter (DD) and without apparent atrophy of RPE were selected for this study. Patients with macular holes 0.4 DD or larger and/or with apparent atrophy of RPE and 1 patient with intraoperative retinal break formation, were excluded from this study. All 23 eyes were followed 6 months or more postoperatively. All patients were treated by one surgeon (Y.S.).

The patient characteristics are shown in Table 1. The subjects consisted of 9 men (9 eyes) and 14 women (14 eyes), 56–77 years of age (mean ± SD = 65.5 ± 5.8 years). The interval between symptom development and surgery was 1–6 months (mean ± SD = 2.9 ± 1.5 months) and the maximum hole diameter was 0.17–0.33 DD (mean ± SD = 0.25 ± 0.06 DD). According to the Gass classification[8] proposed in 1988, stage 2 was observed in 3 eyes, stage 3 in 18 eyes, and stage 4 in 2 eyes. Preoperative visual acuity ranged from 0.09 to 0.8 (mean ± SD = 0.68 ± 0.26 logarithm of minimal angle of resolution [$\log_{MAR}$]). Cataract extractions with intraocular lens implantation had been performed in all phakic eyes for senile cataract or prevention of postoperative nuclear sclerosis. Cataract extraction with implantation of an intraocular lens had been performed previously in 3 eyes.

First, cataract surgery consisting of continuous curvilinear capsulorrhexis, phacoemulsification, and aspiration and intraocular lens implantation was performed in phakic eyes. Then, a standard three-port vitrectomy was performed, followed by creation of posterior vitreous detachment in stage 2 and stage 3 eyes. The center of the posterior lens capsule was opened with a vitreous cutter to prevent postoperative opacification. The ILM was stained using the same method reported by Kadonosono et al.[9] The concentration of indocyanine green (ICG) was 0.06% and the osmolarity was 270 mOsm.[9] A small amount of viscoelastic material containing ICG was placed on the retina around the macular hole for 30 seconds.[9] After removal of the viscoelastic material containing ICG, a small flap was created in the ILM with a microhooked needle.[10] Then the flap of the ILM was grasped and peeled off with vitreous forceps. The area of ILM removal was at least 1 DD surrounding the macular hole. At the end of surgery, the vitreous cavity was exchanged with air. Patients were instructed to maintain prone positioning for only 1 day. After the termination of 1-day prone positioning, patients were instructed to take the lateral position during sleep at night for the following 5–6 days. The restriction on positioning was withdrawn thereafter.

The surgical outcome of the 23 eyes, initial hole-closure rate, complications, and postoperative visual acuity were evaluated.

Table 1. Patient Characteristics*

No.	Age/Sex/Eye	Hole Stage	Symptom (mo)	Hole Diameter (disc diameter)	Visual Acuity		Postoperative Complications	Anatomical Success
					Preop	6 mo		
1	62/F/L	3	2	0.33	0.1	0.9	None	No
2	68/F/L	3	1	0.20	0.4	0.7	None	Yes
3	73/M/L	3	6	0.20	0.3	1.0	IOP↑, PS	Yes
4	63/F/R	3	3	0.33	0.2	0.7	None	No
5	77/M/L	3	3	0.33	0.3	0.8	None	Yes
6	62/F/R	2	3	0.20	0.3	0.6	None	Yes
7	70/F/L	2	5	0.20	0.2	0.3	None	Yes
8	59/F/L	3	4	0.20	0.8	1.0	None	Yes
9	61/M/R	3	3	0.25	0.2	1.0	None	Yes
10	64/M/L	3	3	0.20	0.09	0.3	None	Yes
11	67/M/R	3	3	0.33	0.2	0.8	None	Yes
12	56/F/L	3	1	0.17	0.7	1.0	None	Yes
13	62/M/R	3	4	0.33	0.1	1.0	None	Yes
14	76/M/L	3	3	0.33	0.1	0.5	None	Yes
15	65/F/L	2	6	0.20	0.2	1.0	IOP↑	Yes
16	57/F/L	4	2	0.25	0.2	0.7	None	Yes
17	60/M/R	3	4	0.25	0.3	0.6	None	Yes
18	67/F/L	3	5	0.33	0.1	0.6	None	Yes
19	73/F/R	3	2	0.20	0.3	0.7	None	Yes
20	61/F/L	3	1	0.25	0.2	0.7	None	Yes
21	65/F/R	3	2	0.25	0.2	0.3	None	Yes
22	66/F/L	3	1	0.20	0.2	0.7	None	Yes
23	72/M/R	4	2	0.33	0.1	0.3	Tear	Yes

*F: female, M: male, R: right, L: left, IOP↑: intraocular pressure elevation, PS: posterior synechia, Tear: retinal tear.

Results

Initial Hole-Closure Rate

Anatomical closure of macular holes was achieved in 21 (91.3%) of the 23 eyes by one operation. There were 2 eyes showing nonclosure after the initial surgery (cases 1 and 4 in Table 1). Nonclosure was identified on the 6th and 4th postoperative days in cases 1 and 4, respectively. These two eyes were successfully treated with injection of 100% SF_6 gas (0.75 mL) into the vitreous cavity on the day of diagnosis, followed by face-down positioning for 2–3 days.

Postoperative Visual Acuity

In all 23 eyes, including those re-treated with intravitreal gas injection, postoperative visual acuity at 6 months after surgery ranged from 0.3 to 1.0, and the mean postoperative $\log_{MAR}$ visual acuity was 0.17 ± 0.22. Nineteen eyes (82.6%) achieved visual acuity of 0.5 or better, 15 eyes (65.2%) achieved 0.7 or better, and 6 eyes (26.1%) achieved 1.0. Postoperative visual acuity at 6 months was significantly better than preoperative visual acuity ($P = .013$, paired t-test) (Table 2).

Complications

There were no intraoperative complications. Postoperatively, intraocular pressure was elevated in excess of 30 mm Hg in 2 eyes (8.7%). A retinal break without retinal detachment and posterior synechia occurred in 1 eye (4.3%) each (Table 3). Intraocular pressure was normalized by instillation of a β-blocking agent in both eyes. Retinal break was treated by laser photocoagulation and posterior synechia was managed with synechialysis by YAG laser. These postoperative complications did not influence visual acuity. No reopening of macular hole was encountered in the present study. There was no complication that can be attributed to the ICG staining.

Discussion

During vitreous surgery for macular hole, the vitreous cortex around the hole is removed to release the traction force, which is considered to be a cause of macular hole formation.[9,11] A tamponade with long-acting gas is also utilized to compress a fluid cuff onto the RPE[12] to prevent the vitreous fluid from flowing into the hole.[4] After macular hole surgery, patients used to be instructed to maintain a prone position for 1–3 weeks postoperatively.[1–3,12] ILM removal has been combined with macular hole surgery in recent years, which facilitates shortening of the prone-positioning period.[5,6] Nagata et al[5] reported good outcomes with prone positioning on the first day and only during sleep at night from the 2nd to about the 14th day after vitrectomy combined with ILM removal and long-acting gas tamponade. Park et al[6] reported that 91% of macular holes were closed with one operation with ILM removal and fluid–air exchange followed by 4 days in the prone position.

In our previous study[7] using 11% C_3F_8 gas, the prone positioning period was shortened from 1 week to 1 day. Primary closure of macular hole was obtained in more than 90% of cases without any combined special surgical techniques such as ILM removal. Patients often have difficulties in daily life activity due to black spots in the visual field caused by 11% C_3F_8 gas, which persists in the eyeball for about 6 weeks after surgery.[13] To achieve early and full recovery to normal social life, we decided to perform studies using air as the tamponade material.

Macular holes <0.4 DD and without apparent atrophy of RPE were selected for this study. Our previous study[7] showed that the mean diameter of macular hole was 0.4 DD in the nonclosure group, significantly greater than the 0.3 DD in the primary closure group. Therefore, only macular holes <0.4 DD were treated in the present study. It was believed that the fluid cuff would reattach to the RPE during the 1-day prone-positioning after surgery, and that the pump function of the RPE might help maintain the reattachment until glial cells could fill the macular hole. This is why macular holes without apparent RPE atrophy were selected for this study.

Primary closure of macular hole was achieved in 21 of the 23 eyes (91.3%) after vitreous surgery combined with ILM removal, air tamponade, and 1-day prone positioning. In 2 eyes (cases 1 and 4 in Table 1), primary closure was not obtained. As shown in Table 1, in these 2 eyes there was no apparent preoperative clinical finding

Table 2. Postoperative Visual Acuity at 6 Months*

Mean ± SD in logMAR	0.17 ± 0.22
0.5 or better	19/23 eyes (82.6)
0.7 or better	15/23 eyes (65.2)
1.0	6/23 eyes (26.1)

*logMAR: logarithm of minimal angle of resolution. Values in parentheses are percentages.

Table 3. Postoperative Complications*

Intraocular pressure elevation	2/23 eyes (8.7)
Retinal break	1/23 eyes (4.3)
Posterior synechia	1/23 eyes (4.3)

*Values in parentheses are percentages.

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different from the eyes that did achieve hole closure after the initial surgery. Further investigations should be performed to clarify the possibility and limitation of the surgical procedures used in the present study.

Compared with our previous study,[7] where vitrectomy with 11% C_3F_8 gas and without ILM removal was performed followed by 1-day prone positioning, no significant differences were noted in patient age or duration of symptoms. However, the hole diameter was significantly smaller and the preoperative $\log_{MAR}$ visual acuity was significantly better in the eyes in the present study than in the previous study. The mean $\log_{MAR}$ visual acuity 6 months after surgery was 0.17 ± 0.22 in the present study, better than 0.44 ± 0.31 in our previous study.[7] The reason for the better outcome is that macular holes with a smaller diameter were treated in the present study.

Although transient increases in the intraocular pressure, retinal breaks without retinal detachment, and posterior synechia were noted in some eyes, these postoperative complications were successfully treated by instillation, laser photocoagulation, and YAG laser irradiation. There was no complication that can be attributed to the ICG staining.

Based on the present results, air tamponade with ILM removal followed by 1-day prone positioning was considered to be a useful method for treating macular holes with small diameters and without apparent atrophy of RPE. This method facilitated early recovery to a normal social life.

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