Scleral Infolding Combined with Vitrectomy and Gas Tamponade for Retinal Detachment with Macular Holes in Highly Myopic Eyes

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Purpose: To describe the effectiveness of a surgical procedure, scleral infolding combined with vitrectomy and gas tamponade, for retinal detachment caused by macular holes in highly myopic eyes.

Methods: In a pilot study, scleral infolding was performed in 5 patients with macular holes, who were selected from 10 consecutive highly myopic patients with retinal detachment caused by macular holes (8 patients) or extramacular posterior-pole holes (2 patients), treated during 1 year at Okayama University Hospital. The patients were all women, 48–77 years of age (mean = 63.4 years), who had been followed-up for 1–2 years. Selection criteria for scleral infolding were either second surgeries for reopening of macular holes (2 patients) or residual retinal detachment around macular holes after complete fluid-air exchange with drainage of subretinal fluid at the initial surgery (3 patients). Following vitrectomy and complete epiretinal membrane removal in the posterior pole, the sclera was shortened by infolding on the temporal side. Three mattress sutures with 5-0 Dacron in each quadrant, 6 sutures in total, were placed at a 7-mm anteroposterior interval with posterior sutures located as deep as possible, near vortex veins. Fluid-gas exchange was then done, with or without endophotocoagulation applied around macular holes.

Results: After scleral infolding, macular holes were closed, and the retina was totally attached in all 5 patients. The final visual acuity ranged from 20/2000 to 20/70.

Conclusion: Scleral infolding is a simple and effective procedure for treating retinal detachment with macular holes in highly myopic eyes and could be used as an optional procedure of reoperation for a failed initial vitrectomy. **Jpn J Ophthalmol 2001;45:403–408** © 2001 Japanese Ophthalmological Society

Key Words: High myopia, macular hole, retinal detachment, scleral infolding, scleral shortening.

Introduction

Posterior-pole holes, including macular holes, in highly myopic patients are among the causes for rhegmatogenous retinal detachment. Holes are usually formed in retinochoroidal atrophic areas inside the posterior staphyloma whether they are located in the macula or in extramacular areas.[1,2] Several treatment options have been advocated until now for retinal detachment with macular holes. Macular buckling, although technically difficult, has a favorable anatomical success rate.[3–9] Macular diathermy or cryocautery were used before the introduction of vitrectomy as a method to induce retinochoroidal adhesion.[3,4] Simple gas injection into the vitreous, followed by assumption of a face-down position, is effective for selected cases.[10–13] The most common procedure at this time is vitrectomy with gas tamponade.[8,9,14–16] Recently, complete removal of epiretinal membrane in the posterior pole, even in eyes with a sign of complete posterior vitreous detachment, has been emphasized as an important factor for closure of macular holes.[17–20] However, failure in closing macular holes by an initial surgery or reopening of the hole is still a major problem, especially in patients with diffuse retinochoroidal atrophy in deep

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Table 1. Clinical Data in 10 Consecutive Highly Myopic Patients with Retinal Detachment with Macular or Extramacular Posterior-pole Holes Seen During 1 Year, Classified by Surgical Procedure With or Without Scleral Infolding

Patient No./Age/Sex/Eye*	Location of Hole	Retinal Detachment†	Surgical Procedure‡	Macular PC§ at Initial Surgery
		Patients With Scleral Infolding		
3/64/F/R	Macular	3 Quadrants	VIT+infolding+$SF_6$20%¶	Yes
4/77/F/R	Macular	3 Quadrants	VIT+infolding+$SF_6$30%¶+removal of IOL	Yes
6/56/F/L	Macular	Total	PEA+IOL+VIT+$SF_6$20%+infolding	Yes
9/72/F/L	Macular	3 Quadrants	PEA+IOL+VIT+$C_3F_8$10%+infolding	Yes
10/48/F/R	Macular	3 Quadrants	VIT+infolding+$SF_6$20%	No
		Patients Without Scleral Infolding		
1/61/F/L	Macular	Localized	PEA+IOL+VIT+$SF_6$20% (later PC at office)	No
2/69/F/L	Extramacular	Localized	PEA+IOL+VIT+$C_3F_8$10%	Yes
5/62/F/R	Macular	Localized	PEA+IOL+VIT+$SF_6$20% (later PC at office)	No
7/72/F/L	Macular	Localized	PEA+IOL+VIT+$SF_6$20% (later PC at office)	No
8/59/M/R	Extramacular	Localized	PEA+IOL+VIT+$SF_6$20%+encircling	Yes

*F: female, M: male, R: right eye, L; left eye.
†3 Quadrants: involving 3 quadrants, Localized: localized inside the posterior staphyloma.
‡VIT: vitrectomy, Infolding: scleral infolding, SF_6 20% or 30%: gas tamponade with 20 or 30% sulfur hexafluoride, IOL: intraocular lens implantation, PEA: phacoemulsification and aspiration, $C_3F_8$10%: gas tamponade with 10% C_3F_8, Later PC at office: photocoagulation at follow-up visit around macular hole because of early reopening.
§Macular PC: photocoagulation around macular hole.
¶Second surgery for repairing of macular hole.

posterior staphyloma. In these patients, laser photocoagulation or even cryocautery around the hole and placement of a macular buckle are combined with the initial procedure.

Based on the idea that the anteroposterior length of the retina would be shorter compared to the ocular wall as a result of deepening of the posterior staphyloma, scleral shortening combined with vitrectomy and gas tamponade was recommended by Matsumura and Ogino for retinal datachment with macular holes in highly myopic eyes.[21–23] In their methods, the sclera was shortened by crescent-shaped scleral resection and sutures placed at both edges of the resected area. Before the era of vitrectomy, scleral infolding by sutures on the temporal side combined with macular diathermy was described as an effective method for retinal detachment with macular holes.[7,24,25] In this study, we performed scleral infolding, as a simpler method than scleral resection, together with vitrectomy and gas tamponade, in selected patients with retinal detachment caused by macular holes in highly myopic eyes.

Materials and Methods

In a pilot study, scleral infolding was done in 5 patients with macular holes, who were selected from 10 consecutive highly myopic patients with retinal detachment caused by macular holes (8 patients) or extramacular posterior-pole holes (2 patients), seen during 1 year from April 1998 to March 1999 at Okayama University Hospital (Table 1). Selection criteria for scleral infolding were (1) second surgery to repair reopening of a macular hole 1.5 years after a successful initial vitrectomy and gas tamponade in 1 patient (Patient 3), and to repair reopening of a hole when proliferative vitreoretinopathy developed 2 weeks after the first surgery in 1 patient (Patient 4), or (2) residual retinal detachment in posterior staphyloma under fluid-air exchange with drainage of subretinal fluid even after complete removal of epiretinal membrane at the initial vitrectomy in 3 patients (patients 6, 9, and 10).

The other 5 patients (Table 1) underwent vitrectomy with complete removal of epiretinal membrane followed by gas tamponade with 20–30% sulfur hexafluoride. They showed localized retinal detachment in the posterior pole. Laser photocoagulation was applied around extramacular holes in 2 patients at the end of the initial surgery, and was not applied initially in 3 patients with macular holes. These 3 patients experienced early reopening of the hole and received laser photocoagulation after additional intravitreal injection of pure sulfur hexafluoride and assumption of a 24-hour face-down position. All patients were followed up for 1–2 years after the surgery.

Surgical procedure of scleral infolding combined with vitrectomy is as follows. Under local anesthesia,

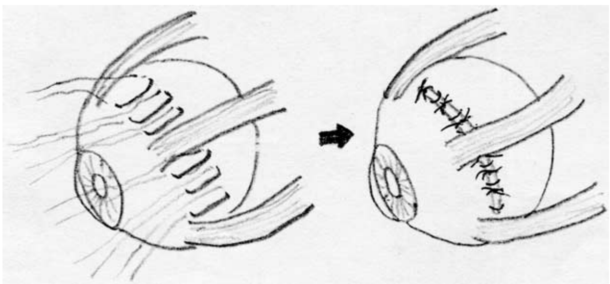

Figure 1. Schematic drawing of scleral infolding.

phacoemulsification and intraocular lens implantation were done through a self-sealing corneoscleral incision in patients 50 years of age or older (patients 6 and 9). The lens was preserved in 1 younger patient 48 years of age (patient 10). Two patients (patients 3 and 4) were pseudophakic after the initial surgery. The intraocular lens was preserved in 1 patient (patient 3) and removed in the other patient (patient 4). In pars plana vitrectomy with the usual three-port system, posterior vitreous detachment, if not present, was induced with suction, and vitreous remnants or epiretinal membranes were peeled off thoroughly from the the retinal surface with a 20-gauge microhooked needle. After bridle sutures were placed under the inferior, lateral, and superior rectus muscles, 6 mattress sutures with 5-0 Dacron were placed on the temporal side of the sclera, with 3 sutures in each of the superotemporal and inferotemporal quadrants (Figures 1 and 2). The sutures at an anteroposterior interval of 7 mm were placed as deep as possible with posterior sutures located just anterior to vortex

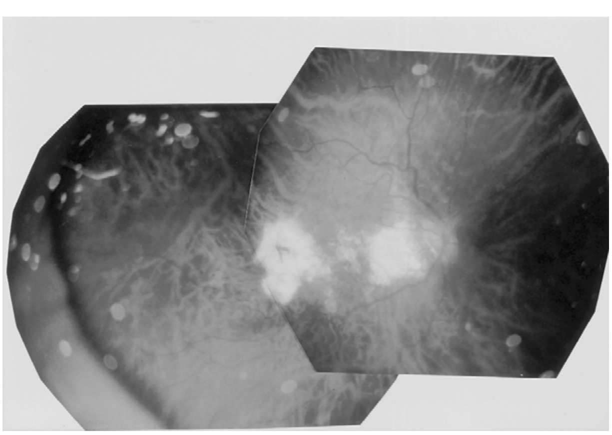

Figure 2. Patient 3. Fundus photograph of right eye after scleral infolding with vitrectomy. Note elevation caused by scleral infolding and degeneration in the posterior pole. Final visual acuity is 20/200 with no astigmatism.

veins, and fastened by infolding the sclera. Fluid-air exchange was then done with drainage of subretinal fluid via macular holes, and laser photocoagulation was applied around the holes in 4 patients, excluding patient 10. Gas tamponade was conducted with 20% (patients 3 and 6) or 30% (patient 4) sulfur hexafluoride or 10% C_3F_8 (patient 9), followed by a 24-hour daily face-down position for 1 week. Patient 9 assumed a sitting position because of leg trouble.

During fluid-air exchange in 3 patients (patients 6, 9, and 10), subretinal fluid behind the detached retina at the edge of the posterior staphyloma still remained even after repeated aspiration through the macular hole with a soft-tipped backflashable needle. Air in the vitreous cavity was replaced by fluid, and scleral infolding was done on the temporal side. The retina could then be reattached by fluid-air exchange.

Corneal astigmatism was assessed preoperatively and postoperatively by autorefractokeratometry and corneal topography. Axial length was measured by A-scan ultrasonography.

Results

The retina was reattached in all 5 patients with scleral infolding as well as in the other 5 patients without scleral infolding in the present series. The final visual acuity after scleral infolding ranged from 20/2000 to 20/70, which was not different from the range of visual acuity (20/300 to 20/200) in the other 5 patients who did not undergo scleral infolding (Tables 2 and 3). The axial length was significantly reduced by scleral infolding (mean $\pm$ SD = 29.41 $\pm$ 0.68 mm versus 25.42 $\pm$ 3.17 mm, before and after the surgery, P = .0474, paired t-test). The reduction of axial length after scleral infolding in 5 patients (Table 2) varied markedly from 1.32 mm to 9.05 mm (mean = 3.99 mm). The axial length before scleral infolding in these 5 patients ranged from 28.50 mm to 30.17 mm (mean $\pm$ SD = 29.41 $\pm$ 0.68 mm), which was longer than, but not significantly different from the axial length (range, 26.70–29.70 mm; mean $\pm$ SD = 28.50 $\pm$ 1.16 mm, Student t-test) in the other 5 patients without scleral infolding (Tables 2 and 3). Scleral infolding induced against-the-rule astigmatism of 4-5 diopters in 3 patients; no astigmatism was found in the other 2 patients after scleral infolding. The degree of astigmatism in these 3 patients did not change during the follow-up period of 1–2 years.

Discussion

Scleral shortening can be accomplished by scleral infolding or scleral resection. Scleral infolding is an

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Table 2. Preoperative and Postoperative Data in 5 Selected Patients with Scleral Infolding

	Visual Acuity		Axial Length§ (mm)		Astigmatism	
Patient No./Age/Sex/Eye*	Preop†	Postop‡	Preop	Postop	Preop	Postop
3/64/F/R	CF	20/200	30.17	25.11	−1.0D Ax180	−1.0D Ax180
4/77/F/R	HM	20/300	29.20	27.88	−1.25D Ax145	−4.0D Ax90
6/56/F/L	HM	20/2000	30.01	27.76	−1.0D Ax180	−4.0D Ax90
9/73/F/L	HM	20/400	29.18	20.13	−1.0D Ax180	−5.0D Ax90
10/48/F/R	20/300	20/70	28.50	26.22	−1.0D Ax180	−0.25D Ax180

*F: female, R: right, L: left.
†CF: counting fingers, HM: hand motion.
‡Postoperative visual acuity is at final examination after follow-up of 1–2 years.
§Axial length after scleral infolding is significantly shorter than that before the surgery(P = .0474, paired t-test).

old surgical procedure for retinal detachment before the introduction of scleral buckling,[24] and was known as an effective procedure even for retinal detachment with macular holes[7,25] before the introduction of vitrectomy. Scleral resection has been recently reintroduced as a method to induce macular translocation in patients with subfoveal neovascular membranes.[26,27] Matsumura and Ogino combined scleral resection with vitrectomy and gas tamponade as a modern surgical method for retinal detachment with macular holes in highly myopic eyes.[21–23] In their method, tenotomy is first performed on the lateral rectus muscle, and a crescent-shaped scleral resection with a maximum anteroposterior width of 6–10 mm is formed to extend over the 180° meridian on the temporal side.

In this study, we used scleral infolding covering the 180° meridian on the temporal side as a simpler method in place of scleral resection. Scleral infolding does not require tenotomy of the lateral rectus muscle. The anteroposterior interval of scleral sutures for infolding was fixed at 7 mm. Posterior sutures were placed as deep as possible, near vortex veins, depending on the surgical field obtained, in order to reduce the degree of astigmatism induced by the procedure. In fact, astigmatism was not induced in 2 patients in the present series, in contrast with the other 3 patients who developed about 5 diopters of against-the-rule astigmatism. The presence or the absence of induced astigmatism would be attributable to the difference in both depth of scleral sutures and scleral rigidity from patient to patient. Overall, the degree of astigmatism induced after scleral infolding in the present patients is apparently less than after scleral resection in the study reported by Matsumura and Ogino.[23]

Table 3. Preoperative and Postoperative Data in 5 Patients Without Scleral Infolding

	Visual Acuity		Axial Length
Patient No./Age/Sex/Eye*	Preop†	Postop‡	Preop
1/61/F/L	20/700	20/200	29.29
2/69/F/L	20/2000	20/300	28.24
5/62/F/R	20/300	20/200	28.59
7/72/F/L	20/200	20/200	26.70
8/59/M/R	HM	20/200	29.70

*F: female, M: male, L: left, R: right.
†HM: hand motion.
‡Postoperative visual acuity is at final examination after follow-up of 1–2 years.

Selection criteria for scleral infolding is difficult to determine at present. In our study, 5 patients with poor prognostic signs were selected for the procedure. Two patients had experienced reopening of the macular hole after vitrectomy and gas tamponade, while 3 patients showed residual retinal detachment inside the posterior staphyloma under fluid-air exchange with drainage of subretinal fluid even after complete removal of epiretinal membranes. These patients had, in common, deep posterior staphyloma with retinal detachment extending to the midperiphery in three or more quadrants. All patients except for patient 10 had diffuse retinochoroidal atrophy inside the posterior staphyloma. The axial length in these 5 patients with scleral infolding was, indeed, longer, although not significantly, than that in the other 5 patients without scleral infolding, indicating deeper posterior staphyloma.

In the 5 patients who were not selected for scleral infolding, extramacular posterior-pole holes were present in 2 patients, while the macular holes in 3 patients were associated with retinal detachment localized inside the posterior staphyloma. Photocoagulation can be applied around extramacular holes to the extent that firm retinochoroidal adhesion is obtained. However, photocoagulation around macular holes, if applied, should be as weak as possible to avoid a large central scotoma. We, therefore, did not apply photocoagulation at the initial surgery in the 3 patients with macular holes and retinal detachment localized inside the posterior staphyloma. Photocoagulation was applied in an office check-up only after early reopening of the holes.

The shortening effect of the sclera appears the same after scleral resection or scleral infolding. The 5 patients with scleral infolding in the present series showed the reduction of axial length ranging from 1.32 mm to 9.05 mm (mean = 3.99 mm), compared with the reduction of axial length of 0.7–3.7 mm (mean = 1.8 mm) in patients after scleral resection as reported by Matsumura and Ogino.[23] These facts suggest that the reduction of axial length, resulting from either scleral infolding or scleral resection, may be mandatory for closure of macular holes with poor prognostic signs. Varying degrees of shortening of the axial length by scleral infolding in the present 5 patients would be attributable to the difference in scleral rigidity and scleral thickness in each patient. The varying shortening effect of scleral infolding poses a problem for the determination of intraocular lens power before surgery, such as in the 2 patients (patients 6 and 9) who underwent intraocular lens implantation simultaneously with scleral infolding. In these patients, the lens power was determined, expecting a high degree of myopia in balance with the high myopia in the other eye. As a result of scleral infolding, the degree of myopia in the operated eyes became moderate.

All the patients attained the vision of 5/400 or better even with photocoagulation around the macular holes. It should be noted that 1 patient (patient 10) with less retinochoroidal atrophy in the posterior staphyloma attained a visual acuity of 20/70 after scleral infolding. Photocoagulation was not applied to this patient. Further studies are necessary to determine whether photocoagulation around macular holes is necessary or not for their closure after scleral infolding combined with vitrectomy and gas tamponade.

In conclusion, scleral infolding combined with vitrectomy and gas tamponade is a simple and effective procedure to close macular holes with poor prognostic factors. The procedure could be used as an optional method of reoperation for a failed initial vitrectomy. There was selection bias in this pilot study because of the criteria for selecting patients and the variations in the patients' baseline characteristics. Patient selection criteria for this procedure should be reviewed and determined after the further accumulation of cases.

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