ELSEVIER

Complications Associated With Vortex Vein Damage in Scleral Buckling Surgery for Rhegmatogenous Retinal Detachment

Norihito Doi, Akinori Uemura and Kumiko Nakao

Department of Ophthalmology,
Kagoshima University Faculty of Medicine, Kagoshima, Japan

Purpose: To further understand postoperative complications after vortex vein damage during scleral buckling surgery.

Methods: The records of 34 patients (34 eyes) with vortex vein damage during scleral buckling surgery for rhegmatogenous retinal detachment were reviewed and compared with the records of 410 eyes undergoing similar surgery without vortex vein damage.

Results: Postoperative complications were noted in 16 eyes (47%) of the damaged vortex vein group. The incidence of choroidal detachment, vitreous opacities, intraocular pressure elevation, and vitreous hemorrhage were 27%, 18%, 9%, and 6%, respectively, with a higher incidence than in the group without vortex vein damage. Other complications included development of epiretinal membrane (9%), subretinal hemorrhage (3%), and anterior segment ischemia (3%). Serous choroidal detachment occurred in the early postoperative days and subsided within 3 weeks. Vitreous opacification became marked in the later periods and continued for 2 months or longer. The incidence of postoperative choroidal detachment in the vortex vein damage group was related to the patient's age ($P = .002$) and the cutting of the vortex veins ($P = .048$), but was not related to preoperative conditions of retinal detachment or the number of vortex veins damaged. All the eyes except one achieved retinal reattachment after initial surgery.

Conclusions: Choroidal detachment and vitreous opacity are common after scleral buckling surgery with vortex vein damage. Although intervention of the vortex veins during scleral buckling surgery is acceptable when performing otherwise difficult to achieve ample scleral indentation, it should be minimized to avoid increased incidence of postoperative complications. **Jpn J Ophthalmol 1999;43:232–238**

Key Words: Postoperative complications, retinal detachment, scleral buckling, vortex vein damage.

Introduction

A wide range of complications may occur following classic scleral buckling surgery for rhegmatogenous retinal detachments, including intraocular hemorrhage, glaucoma, anterior segment ischemia, infection and extrusion of the buckling material, choroidal detachment, cystoid macular edema, macular pucker, eye movement disorder, and refractive change. The incidence and extent of these complications depend on the preoperative condition, intraoperative procedure, and postoperative management.[1,2] Insult to the vortex veins during scleral buckling surgery increases the risk of complications.[3–6] Although complications associated with vortex vein damage are widely recognized, few reports have dealt with a large series of cases, and information relating to the incidence and long-term outcome is limited because of the ambiguous definition describing interference with the vortex vein. The purpose of this study is to determine the incidence of postoperative complications after vortex vein damage during scleral buckling

Received: April 21, 1998
Address correspondence and reprint requests to: Norihito DOI, MD, Department of Ophthalmology, Kagoshima University Faculty of Medicine, 8-35-1 Sakuragaoka, Kagoshima 890-8520, Japan

Published by Elsevier Science Inc.

0021-5155/99/$–see front matter
PII S0021-5155(99)00009-X

surgery and the relationship between preoperative findings of retinal detachment, surgical procedures, and their complications.

Materials and Methods

Basic data were obtained from the patient records to identify patients who underwent scleral buckling surgery for rhegmatogenous retinal detachment in the Kagoshima University Hospital between 1990 and 1994. Patients with retinal detachment associated with proliferative vitreoretinopathy, giant retinal tear, penetrating injuries, or vascular occlusive diseases were excluded. Four hundred and forty-four eyes of 429 patients were reviewed for this study. Most of the retinal detachments were caused by equatorial atrophic retinal holes or tractional retinal tears. The patients underwent scleral buckling surgery with either an episcleral exoplant or intrascleral implant technique using solid silicone rubber or silicone rubber sponge. Solid silicone rubber 6–10-mm wide was used in both techniques. Silicone rubber sponge was used radially or circumferentially in patients with a single break not associated with extensive lattice degeneration. An additional encircling procedure or drainage of subretinal fluid was performed when indicated. All surgeries were performed by one of the authors (AU). Routine preoperative and postoperative examinations included binocular indirect ophthalmoscopy, slit-lamp biomicroscopy using a three-mirror contact lens, ocular ultrasonography, applanation tonometry, perimetry, and electroretinography.

Of the 444 eyes, 34 (8%) underwent intraoperative intervention to the vortex veins because it was judged otherwise impossible to achieve ample scleral indentation. Intervention consisted of cutting after cauterizing with diathermy at the scleral exit or compression with silicone materials. These eyes were referred to as the damaged vortex vein group. There was no intentional damage to the vortex vein in the remaining 410 eyes of 395 patients (92%). These eyes were referred to as the undamaged vortex vein group. The mean age of patients in the undamaged vortex vein group was 47.4 years (range, 8–88 years); there were 230 men and 165 women.

A statistical comparison was made relating to the incidence of postoperative complications between the damaged and undamaged vein groups, using univariate procedures (eg, Fisher's exact test for dichotomous variables, *t*-test for a continuous variable). In addition, the damaged group was divided into cases with and without two major complications, serous choroidal detachment or vitreous opacities. A statistical comparison was made of the subgroups in relation to preoperative findings of retinal detachment and surgical procedures. The significance level was set at $P < .05$.

Results

Table 1 summarizes the clinical data of the vortex vein damaged group, which consisted of 34 eyes of 34 patients (mean age = 53 years; range, 21–77 years), 21 men and 13 women. Mean follow-up period was 24.1 months (range, 1–72 months). A total of 63 vortex veins (mean number = 1.85; range 1–4) were obviously damaged during surgery. Of the 34 eyes, 10 (29.4%) underwent complete cutting of the vortex veins (mean number of damaged veins = 1.7; range, 1–4), 21 (61.8%) had compression (mean number of damaged veins = 1.7; range, 1–3), and 3 (8.8%) had both cutting and compression (mean number of damaged veins = 3.0; range 2–4). The damaged vortex veins were distributed from within two quadrants of the fundus.

Serous choroidal detachment occurred in 9 eyes (26.5%) of this group, becoming manifest as early as the next day after surgery and involving between the far periphery and the equator in one quadrant (3 eyes), two quadrants (5 eyes), and four quadrants (1 eye). This complication was resolved spontaneously within 3 weeks (mean = 9.2 days; range, 1–20 days).

Postoperative opacity in the vitreous cavity, which was distinct from transient vitreous irritation after retinal detachment surgery, occurred in 6 eyes (17.6%) a few weeks after surgery and lasted for the subsequent weeks of follow-up. In two eyes, this complication lasted for over 3 months before eventually being resolved.

Other complications observed in this group included elevation of intraocular pressure (3 eyes), development of epiretinal membrane (3 eyes), vitreous or subretinal hemorrhage (3 eyes), and anterior segment ischemia (1 eye). None of the eyes developed hemorrhagic choroidal detachment or endophthalmitis.

The incidence of choroidal detachment or vitreous opacity after vortex vein damage was not significantly related to the number of vortex veins damaged or the number of quadrants involved; 4 of 6 eyes (67%) with the cutting of two vortex veins in comparison to 5 of 7 eyes (71%) with the cutting of one vein developed these complications. Similarly, these complications developed in 2 of 3 eyes (67%) with the cutting of veins in two neighboring quadrants, and in 7 of 10 eyes (70%) with cutting of veins in one quadrant.

Jpn J Ophthalmol
Vol 43: 232–238, 1999

Table 1. Clinical Data of Cases Undergoing Damage to Vortex Vein During Scleral Buckling Surgery for Rhegmatogenous Retinal Detachment

Case	Age (Years)	Sex	Laceration of Vortex Vein: Cut (n)	Compress (n)	Range (Q)	Postoperative Complications: CD	VO	OH	ERM	VH/SH	Follow-Up Time (Months)	Retina Attached	Visual Acuity: Preoperative	Final
1	41	M	0	2	2	–	–	–	–	–	54	Yes	0.04	1.2
2	52	F	0	2	2	–	–	–	–	–	6	Yes	0.05	0.1
3	22	M	0	2	2	–	–	–	–	–	9	Yes	0.5	0.9
4	59	M	0	1	1	–	–	–	–	+	12	No-Yes	0.7	0.9
5	39	F	0	3	2	–	–	–	–	–	42	Yes	1.2	1.2
6	68	M	1	0	1	–	+	–	–	–	72	Yes	1.5	0.7
7	62	F	0	2	1	4Q	–	–	–	–	48	Yes	0.8	0.9
8	57	F	2	0	1	–	+	–	–	–	36	Yes	HM	0.1
9	63	M	0	1	1	–	+	+	–	–	12	Yes	0.08	0.2
10	60	M	0	1	1	–	–	–	+	–	12	Yes	1.0	0.6
11	43	F	0	2	1	–	–	–	–	–	24	Yes	0.8	0.4
12	66	M	0	1	1	–	+	+	–	+	1	Yes	0.2	0.02
13	59	M	1	0	1	2Q	–	+	–	–	24	Yes	0.01	0.1
14	52	M	1	0	1	–	–	–	–	–	36	Yes	1.2	0.9
15	61	M	0	2	1	2Q	–	–	–	–	36	Yes	0.1	1.0
16	60	M	2	0	2	2Q	–	–	+	–	42	Yes	1.0	0.1
17	61	M	2	0	1	–	–	–	–	–	24	Yes	0.08	1.5
18	69	M	0	2	1	–	–	–	–	–	4	Yes	HM	0.07
19	40	F	1	1	2	–	+	–	–	–	30	Yes	0.08	0.4
20	59	F	2	0	1	1Q	–	–	–	–	30	Yes	0.05	0.7
21	21	M	0	2	2	–	–	–	–	–	18	Yes	0.9	1.2
22	42	F	0	2	2	–	–	–	–	–	30	Yes	0.5	0.8
23	31	F	0	2	2	–	–	–	–	–	21	Yes	1.2	0.8
24	77	F	0	1	2	–	–	–	–	–	6	Yes	HM	0.2
25	61	M	1	2	2	2Q	–	–	–	+	18	Yes	0.9	1.2
26	67	M	1	0	1	1Q	–	–	–	–	30	Yes	0.9	1.5
27	67	M	2	2	2	–	–	–	–	–	30	Yes	0.5	0.5
28	65	F	0	1	1	1Q	–	–	+	–	12	Yes	0.7	0.2
29	60	M	4	0	2	2Q	+	–	–	–	24	Yes	0.5	0.7
30	44	F	0	2	2	–	–	–	–	–	24	Yes	0.06	0.3
31	55	M	0	3	2	–	–	–	–	–	18	Yes	0.6	0.6
32	40	F	1	0	1	–	–	–	–	–	12	Yes	0.06	0.1
33	60	M	0	2	1	–	–	–	–	–	12	Yes	0.8	0.6
34	21	M	0	1	1	–	–	–	–	–	12	Yes	0.07	0.2

CD: choroidal detachment, ERM: epiretinal membrane, HM: hand motions, OH: ocular hypertention, Q: number of quadrants affected, SH: subretinal hemorrhage, VH: vitreous hemorrhage, VO: vitreous opacity.

Intraoperative damage to the vortex veins did not influence the anatomic results for repair of the retinal detachment. Initial surgery led to reattachment of the retina in 33 eyes (97%) and a repeat surgery was successful with the remaining one eye. Figure 1 illustrates a comparison between the preoperative and final visual acuity in the vortex vein damaged group. Despite the favorable anatomic results, 9 (26.5%) of the 34 eyes showed a decreased visual acuity of 2 or more lines. The presumed causes of decreased vision included development of epiretinal membrane in the macula in 3 eyes, vitreous opacities in 1, progression of cataract in 2, and undefined causes in 3.

Table 2 summarizes the incidence of postoperative complications after surgery in both groups. The incidence of serous choroidal detachment ($P < .001$), vitreous opacity ($P < .001$), ocular hypertension ($P = .034$), and vitreous hemorrhage ($P = .049$) were significantly higher in the vortex vein damaged group than in the undamaged group.

Tables 3 and 4 compare the preoperative findings of retinal detachment and the surgical procedure between eyes with and without two major complications, choroidal detachment, and vitreous opacity. Choroidal detachment was likely to occur in elderly patients ($P = .002$). In addition, cutting of the vortex veins caused a significantly higher incidence of cho-

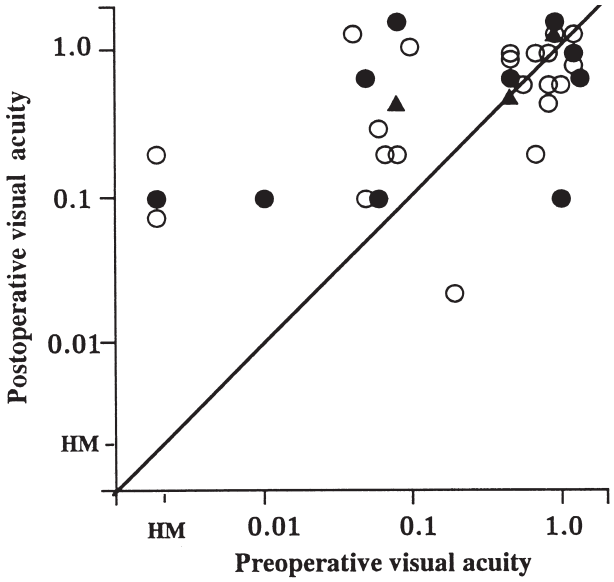

Figure 1. Preoperative and postoperative visual acuity in 34 eyes with rhegmatogenous retinal detachment that underwent vortex vein intervention during scleral buckling surgery. Note that the majority of cases had an improvement in postoperative visual acuity, but some cases had decreased visual acuity. White circles represent cases receiving compression of vortex veins, closed circles cutting, and closed triangles both compression and cutting. HM: hand motion.

roidal detachment when compared to compression only; 5 of 10 eyes (50%) had the complication after cutting of the vortex veins compared to 3 of 21 (14%) after compression ($P = .048$). Although such a relationship was not observed between eyes with and without postoperative vitreous opacity, the incidence of the complication was significantly higher in eyes undergoing intraocular gas injection in addition to damage to the vortex vein ($P = .021$).

Discussion

These results indicate that the major complications observed following interference with the vortex vein during scleral buckling surgery are serous choroidal detachment and vitreous opacity. Although these complications also occur without damage to the vortex vein, the significantly higher incidence of the complications after intervention provides evidence that damage to the vortex vein may be responsible for their occurrence.

Serous choroidal detachment is widely recognized as a common complication following vortex vein damage. Its incidence has been reported to be 33%[6]–37%.[3] Excessive accumulation of suprachoroidal fluid due to congestive choroidal vasculature is assumed to be the pathogenesis of this complication. Vortex vein intervention in this study was delivered by either dissection at the scleral exit or compression by buckling materials. Our study demonstrated that patients with the cutting of the vortex veins had a higher rate of serous choroidal detachment than patients with only compression of the vessel. The degree of vein occlusion, complete occlusion or partial occlusion, will explain the results, although other factors may be associated with the development of this complication. Regarding compression of the vortex veins with buckling materials, the width of scleral indentation or additional encircling procedures did not show a significantly higher rate of choroidal detachment, probably because of variations in strength and duration of the compression. Hawkins and Schepens[3] reported that the incidence of serous choroidal detachment increases with age at the time of surgery, the incidence being 3% in patients aged younger than 20 years, 20% if aged between 21 and 60 years, and 33% if aged 61 years and older. We also confirmed an increasing risk of choroidal detachment in elderly patients.

Table 2. Postoperative Complications After Scleral Buckling Procedure for Rhegmatogenous Retinal Detachment With and Without Intraoperative Vortex Vein Intervention

Complication	With Vortex Vein Damage (n = 34)	No Vortex Vein Damage (n = 410)	P[a]
Serous choroidal detachment	9 (26.5%)	26 (6.3%)	<0.001
Vitreous opacification	6 (17.6%)	7 (1.7%)	<0.001
Ocular hypertension	3 (8.8%)	7 (1.7%)	0.034
Vitreous hemorrhage	2 (5.8%)	3 (0.7%)	0.049
Subretinal hemorrhage	1 (2.9%)	19 (4.6%)	0.537
Anterior segment ischemia	1 (2.9%)	2 (0.5%)	0.213
Epiretinal membrane	3 (8.8%)	14 (3.4%)	0.133

[a]Fisher's exact test.

Jpn J Ophthalmol
Vol 43: 232–238, 1999

Table 3. Clinical Data of Cases With and Without Choroidal Detachment After Vortex Vein Damage in Scleral Buckling Surgery for Rhegmatogenous Retinal Detachment

Features	Choroidal Detachment		P[a]
	With (n = 9)	Without (n = 25)	
Mean age ± SD (years)	61.6 ± 2.7	50.0 ± 15.8	0.002
Sex (M/F)	6/3	16/9	0.610
Vortex vein			
Cutting	5	5	0.048
Compression	3	18	
Both	1	2	
Retinal break			
Present	9	21	0.273
Not identified	0	4	
Feature[b]			
Tractional tear	9	18	0.328
Atrophic hole	0	3	
Size[b]			
<3 Disc-diameter	4	8	0.528
Number[b]			
Three or more	2	4	0.763
Location[b]			
Equator	7	18	0.857
Posterior	2	3	
Extent of detachment			
<2 Quadrants	6	10	0.163
≥2 Quadrants	3	15	
Surgical procedure			
Buckling			
Implant	8	18	0.298
Exoplant	1	7	
Extent of buckling			
<2 Quadrants	8	17	0.225
≥2 Quadrants	1	8	
Equatorial encircling	8	22	0.719
Subretinal fluid drainage	9	23	0.535
Intraocular gas injection	4	9	0.475
Paracentesis	3	5	0.351

[a]Fisher's exact test, except for age using unpaired *t*-test.
[b]Without choroidal detachment, n = 21, with exclusion of four cases with unidentifiable retinal break.

Table 4. Clinical Data of Cases With and Without Vitreous Opacification After Vortex Vein Damage in Scleral Buckling Surgery for Rhegmatogenous Retinal Detachment

Features	Vitreous Opacities		P[a]
	With (n = 6)	Without (n = 28)	
Mean age ± SD (years)	59.0 ± 10.1	51.8 ± 15.1	0.181
Sex (M/F)	4/2	18/10	0.649
Vortex vein			
Cutting	3	7	
Compression	2	19	0.176
Both	1	2	
Retinal break			
Present	6	24	0.441
Not identified	0	4	
Feature[b]			
Tractional tear	6	21	0.496
Atrophic hole	0	3	
Size[b]			
<3 Disc-diameter	3	10	0.531
Number[b]			
Three or more	2	4	0.925
Location[b]			
Equator	6	19	0.299
Posterior	0	5	
Extent of detachment			
<2 Quadrants	3	13	0.611
≥2 Quadrants	3	15	
Surgical procedure			
Buckling			
Implant	6	20	0.171
Exoplant	0	8	
Extent of buckling			
<2 Quadrants	4	21	0.826
≥2 Quadrants	2	7	
Equatorial encircling	6	24	0.441
Subretinal fluid drainage	6	26	0.674
Intraocular gas injection	5	8	0.021
Paracentesis	1	7	0.562

[a]Fisher's exact test, except for age using unpaired *t*-test.
[b]Without vitreous opacities, n = 24, with exclusion of four cases with unidentifiable retinal break.

Long-lasting vitreous opacities that have been described here are distinct from the mild intraocular irritation after retinal detachment surgery and are characterized by their unresponsiveness to anti-inflammatory medication, and their frequency after intraocular gas injection. It is noticeable that these complications continued 2–3 months after complete closure of retinal breaks and reattachment of the retina. This type of complication has not been explicitly described previously.[5] Exudation from the choroid caused by congestion of the choroidal vessels may be responsible for this complication. Our study also showed that intraocular gas injection to the eyes together with vortex vein damage increased the incidence of the complication. Constable and Swann[7] suggested that intravitreous gases caused an increase in ocular vascular permeability, as demonstrated by the vitreous inflow of serum protein in monkeys. We do not know which factors are more responsible for the complication. It is plausible, however, that vitreous opacities are more significant when intraocular gas is used and vortex vein damage occurs in the same eye.

Development of subretinal hemorrhage, anterior segment ischemia, and epiretinal membrane were occasional complications in our study. Vortex vein occlusion is also an important factor in the development of anterior segment ischemia after scleral buckling surgery.[4] Hayreh and Baines[8] have shown that anterior segment ischemia may be produced experimentally in primates by occlusion of the vortex veins. Although the incidence of anterior segment ischemia in vein-damaged patients was comparable to that in patients with no vein damage, because of the small sample of patients, we should be aware of the occurrence of ischemia after surgery in patients with vortex vein damage.

It is widely accepted that the severity of complications resulting from vortex vein occlusion is worse when many vessels are damaged. Experiments in monkeys and rabbits demonstrated that damage to more than two vortex veins may induce increasingly marked complications[8] and that the normal choroidal circulation is reduced to 73.0% after dissection of two vortex veins, 49.2% after three, and 4.4% after four.[9] The number of vortex veins varies between postmortem human eyes, ranging from 5–8 (mean = 5.8),[10] from 3–8 (mean = 5.3),[11] or from 4–7 (mean = 4.8).[12] These facts indicate the existence of a second or third vortex vein in a quadrant. In fact, we could see two or more vortex veins in each quadrant during surgery. From this point of view, it is plausible that damage to a single vortex vein in eyes with two or more veins in the quadrant may be less likely to cause complications because damage to the choroidal circulation is possibly compensated for by collateral drainage.[11] On the other hand, the damage to a single vortex vein in eyes with only one vein in each quadrant may cause complications. In this current study, we could not confirm the clinical relationship between the number of vortex veins or fundus quadrants involved and the occurrence of major complications, probably because of the small series of patients and the variety in the vortex vein distribution.

Despite postoperative complications associated with vortex vein damage, the anatomic results in the present study were favorable. Therefore, damage to the vortex veins within two quadrants may be acceptable as a choice of procedure in terms of retinal reattachment when compared to the difficulty in achieving sufficient scleral indentation. However, intervention to the vortex veins should be minimized because of an increased incidence of postoperative complications. In addition, vortex vein damage may have an influence on postoperative visual acuity. Two patients with vortex vein damage in our series had decreased visual acuity for no obvious reason after surgery. Visual outcomes after scleral buckling surgery with vortex vein damage need to be further investigated.

In conclusion, we were able to confirm that the incidence of several postoperative complications increases after scleral buckling surgery with vortex vein damage. Fortunately, these complications were benign in nature and the anatomic results after surgery were favorable when the damage was limited. Recently, primary vitrectomy surgery to repair rhegmatogenous retinal detachment has become widely used to avoid damage to the vortex vein. Although the major complications observed in this study were rare after vitrectomy surgery,[13] there was potential risk of vision-threatening complications. It is difficult to prove which procedure—vitrectomy surgery or scleral buckling surgery—is better in treating retinal detachment resulting from a posterior break. The ophthalmologist should always be aware of the potential risks of both when considering the surgical procedure.

The encouragement of Prof. Norio Ohba during this study is acknowledged. This work was supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Science, Sports and Culture of Japan.

References

1. Williams GA, Aaberg TM. Techniques of scleral buckling. In: Glaser BM, Michels RG, eds. Retina. Vol. 3. St. Louis: CV Mosby, 1989:111–49.
2. Wilkinson CP, Rice TA. Complications of retinal detachment surgery and its treatment. Michels retinal detachment. St. Louis: CV Mosby, 1997:979–1079.
3. Hawkins WR, Schepens CL. Choroidal detachment and retinal surgery: a clinical and experimental study. Am J Ophthalmol 1966;62:813–9.
4. Robertson DM. Anterior segment ischemia after segmental episcleral buckling cryopexy. Am J Ophthalmol 1975;79:871–4.
5. Ideta H, Ishikawa M. Complications of vortex vein damage in retinal detachment surgery. Rinsho Ganka (Jpn J Clin Ophthalmol) 1983;37:407–11.
6. Uchino M, Okuno H, Narumi C. The relationship between postoperative complications and the vortex vein in retinal detachment. Nihon Ganka Kiyo (Folia Ophthalmol Jpn) 1983; 34:2290–5.
7. Constable IJ, Swann DA. Vitreous substitution with gases. Arch Ophthalmol 1975;93:416–9.
8. Hayreh SS, Baines JAB. Occlusion of the vortex veins: an experimental study. Br J Ophthalmol 1973;57:217–38.
9. Takahashi S. Studies on choroidal blood flow using the hydrogen clearance method. III. Effects of vortex vein occlusion. Nihon Ganka Kiyo (Folia Ophthalmol Jpn) 1982;33:958–61.
10. Rutnin U. Fundus appearance in normal eyes. Am J Ophthalmol 1967;64:821–39.

Jpn J Ophthalmol
Vol 43: 232–238, 1999

11. Lim MC, Bateman JB, Glasgow BJ. Vortex vein exit sites. Scleral coordinates. Ophthalmology 1995;102:942–6.
12. Sanuki M, Sakai S, Watanabe I. The number and location of vortex vein. Ganka Rinsho Iho (Jpn Rev Clin Ophthalmol) 1983;77:715–7.
13. Uemura A, Nakao K. A comparison between scleral buckling procedure and vitrectomy for the management of uncomplicated retinal detachment caused by posterior retinal break. Nippon Ganka Gakkai Zasshi (J Jpn Ophthalmol Soc) 1995;99:1170–4.