CASE SERIES

Outcomes of Retinectomy of 180° or more in Retinal Detachment with Advanced Proliferative Vitreoretinopathy

Manish Nagpal, Pravin Jain, Kamal Nagpal, Anil Patil

Consultant, Department of Retina and Vitreous, Retina Foundation, Ahmedabad, Gujarat, India

Correspondence: Manish Nagpal, Consultant, Department of Retina and Vitreous, Retina Foundation, Ahmedabad, Gujarat India , e-mail: drmanishnagpal@yahoo.com

ABSTRACT

Aim: To study the functional and anatomic outcomes of retinectomy of 180° or more in eyes with rhegmatogenous retinal detachment (RD) with advanced proliferative vitreoretinopathy (PVR) Grade D.

Materials and methods: A retrospective analysis of 51 eyes that underwent pars-plana vitrectomy (PPV) with 180° or more of retinectomy for RD with PVR Grade D was done. Main outcome measures included retinal reattachment, visual outcomes and complications at a follow-up of 12 months. Separate analysis for these parameters was also carried out for subgroup of one-eyed patients.

Results: Overall retinal reattachment was achieved in 86.3% cases with mean improvement in BCVA of 0.59 ± 0.91 (statistically highly significant) at final follow-up. In subgroup of one-eyed patients (n = 11), retinal reattachment was achieved in 81.8% eyes with mean improvement of 0.52 ± 0.62 (significant) and 45.4% patients gained ambulatory vision. Main complications included recurrent PVR, optic atrophy, secondary glaucoma and hypotony.

Conclusion: Retinectomies of 180° or more can help alleviate intractable traction in eyes with advanced PVR to achieve significant anatomical and functional improvement. This approach was found to be particularly valuable in one-eyed patients in order to achieve ambulatory vision.

Keywords: Retinectomy, Proliferative vitreoretinopathy, Retinal detachment, Vitrectomy.

INTRODUCTION

Retinal traction hinders apposition of neurosensory retina to the retinal pigment epithelium. Adequate relief of retinal traction is essential for long-term retinal reattachment in eyes with proliferative vitreoretinopathy (PVR). Relaxing retinectomy, by alleviation of intractable traction which remains unrelieved by membrane dissection and scleral buckling, forms an important adjunct to achieve anatomical reattachment in cases of severe PVR.[1] In addition to complex PVR, retinectomies have been attempted in conditions, such as high myopia with loss of retinal elasticity, proliferative vasculopathies, like diabetic retinopathy, penetrating trauma, particularly in presence of retinal incarceration and large subretinal proliferations.[1-3]

Several published reports have presented results of retinectomy for complex retinal detachments (RD) with variable rates of anatomic reattachment (14-80%).[3-9] Reported favorable outcomes of this technique include retinal reattachment, improvement or stabilization in visual acuity, regaining of ambulatory vision and visual field, etc.[1,3-9] However, a review of literature shows lack of homogenous cohorts in analysis of this technique. Some studies have included multietiological cases of PVR (e.g. traumatic retinal incarcerations, tractional retinal detachments in vasoproliferative vasculitides, acute retinal necrosis, etc). [1-5,7,9] Further, we found that grades and extent of PVR were either not clearly specified (only stated as advanced PVR)[6] or there was a heterogeneous selection of cases as far as grading of PVR was concerned (PVR C-D,[4] subretinal fibrosis,[5] anterior PVR).[3-5] Few authors have made no mention regarding the size of retinectomy,[4,5] while still others have presented combined results of cases with varying sizes of retinectomies.[3]

One of the important indications for this type of intervention in advanced PVR cases is in one-eyed patients, where achievement of at least ambulatory vision is important. Ambulatory vision is defined as being able to see objects and move around a room without stumbling or bumping into obstacles (although there has been a general lack of consensus about the actual value of visual acuity which defines ambulatory vision).[10-13]

In order to achieve standardization of pre- and intraoperative variables, we undertook this retrospective study to demonstrate the efficacy of retinectomies of 180º or more in eyes with PVR-D only. Further, we also wanted to study the outcomes of this intervention in the subgroup of one-eyed patients.

PATIENTS AND METHODS

Following approval from the institutional ethics committee, case records of 178 patients having retinal detachments with PVR who underwent pars-plana vitrectomy (PPV) and relaxing retinectomy during January 2007 to December 2010 were reviewed. Of these, we excluded eyes with tractional or combined-etiology (e.g. diabetic, vasculitis, trauma) RD, eyes that underwent retinectomies less than 180º and those with PVR grade A, B or C or inadequate follow-up (<12 months).

Fifty-one eyes of 51 patients met with all the inclusion criteria, namely, presence of rhegmatogenous RD with PVR grade D, that had undergone retinectomy of 180 degrees or more, and had a minimum postoperative follow-up of 12 months. Case records of these 51 patients were scrutinized and pre-, intra-and postoperative data were extracted and filled up in a standardized format.

Preoperative data collected for each patient included age, sex, best corrected visual acuity (BCVA) on Snellens chart, IOP, lens status, number and details of previous surgery/ies and one-eyed status. Baseline PVR was documented based on preoperative retinal charting and confirmed intraoperatively. Grading of PVR was done using the classification proposed by the Retina Society Terminology Committee.[14] Intraoperative data were recorded from individual surgical notes and included details of the standardized PPV, extent of retinectomy, type of retinopexy, use of scleral buckle, type of tamponade, other adjunct surgical procedures (e.g. cataract extraction, membrane peelings, etc.) and any complications encountered during surgery. Postoperative data recorded were BCVA, anatomical retinal status, number and details of reoperations, postoperative PVR, IOP and removal of silicone oil during and at final follow-up. BCVA on Snellens chart was converted to logMAR for statistical purposes.

All surgeries had been performed by single surgeon (MN). Fourty-one eyes (81.4%) underwent 2.5 mm (# 240) silicone band encirclage, while 10 eyes (19.6%) had an encircling buckle already present from a previous surgery. Following encirclage 20 gauge 3-port PPV, using Accurus® (Alcon Laboratories, Inc) vitrectomy system was performed on each eye, with meticulous removal of PVR membranes. Perflurocarbon liquid was then injected to flatten the posterior retina, allowing assessment of residual tractional elements and aiding removal of residual membranes.

Relaxing retinectomy had been considered at this stage if maximum possible tightening of scleral buckle failed to relieve the retinal contraction. Intraocular diathermy was used at the proposed site of retinectomy to prevent bleeding. Retinectomy was performed with vitreous cutter as anteriorly as possible in the area of retinal stiffening and extended circumferentially as far as necessary to relieve all retinal contraction and one clock hour on either side involving normal retina. Care was taken to remove as much as possible of the peripheral nonfunctioning anterior retinal flap to minimize chances of ischemia, neovascularization and reproliferation.[15] Hemostasis was achieved with raised intraocular pressure and endodiathermy, whenever needed. Further PFCL was injected to ensure total flattening of retina beyond the cut edges of the retinectomy. Three to four rows of laser barrage were carried out along the posterior edge of retinectomy. PFCL was exchanged for silicone oil (siloil 1000, Intas). Postoperative prone positioning was advised in all patients for 10 to 14 days. Follow-up data of first postoperative day, day 7, months 1, 3, 6 and 12 were recorded for all patients.

Retinal reattachment was defined either as complete reattachment (360 degree) or partial reattachment (attached macula with localized peripheral tractional elevation associated with reproliferation). IOP of ≥ 21 mm Hg was considered high and hypotony was defined as IOP < 5 mm Hg.[1,3] For the purpose of this study, BCVA of 4/200 (0.02) or better was considered as ambulatory vision. Statistical significance was calculated based on negative ranking using Wilcoxon Signed Ranks test, Mann-Whitney test, Chi-square and Student t-test as appropriate.

RESULTS

Details of baseline (preoperative), intra- and postoperative data are summarized in Table 1. The mean age of patients was 56 (range 5-74) years and 38 (74.5%) were males. Postoperative follow-up ranged from 12 to 33 months, mean follow-up being 12.6 months. 33.3% (17 eyes) had at least one prior surgery for retinal detachment, either at our center or elsewhere. Twenty-eight (54.9%) eyes underwent retinectomy ranging from 180 to 270 degrees, while rest 23 (45.1%) eyes needed more than 270 degrees, of retinectomy. Anatomic attachment was achieved in all eyes during surgery.

During postoperative follow-up period, three eyes underwent revision of vitrectomy once during follow-up and all achieved partially attached retina. One eye underwent revision of vitrectomy twice for redetachment but had unsettled retina at the final follow-up. In addition, 6 other eyes developed recurrent advanced PVR with fibrosis of which 2 patients were advised (but did not consent) resurgery.

At final follow-up, retinal reattachment was achieved in 44 (86.3%) eyes of which 60.8% (31 eyes) had complete retinal reattachment, while 25.5% (13 eyes) had partial reattachment and 7 eyes (13.7%) had unattached retina at final follow-up. Silicone oil had been removed in seven eyes till final follow-up.

Visual outcomes: The details of presenting and final BCVA are given in Table 2. The mean presenting BCVA was 2.92 ± 0.27 and mean final acuity was 2.33 ± 0.84 with the mean improvement of 0.59 ± 0.91 on logMAR acuity scale (statistically highly significant, $p < 0.005$). At final follow-up, 29 (56.9%) eyes showed improvement, 12 (23.5%) eyes maintained, while 10 (19.6%) eyes had deterioration from their presenting BCVA (Fig. 1). 9.3% eyes had ambulatory vision (BCVA ≥ 0.02) preoperatively that increased to 34.8% at final follow-up.

One-eyed patients: 11(21.5%) of the 51 patients were one-eyed, i.e. having no visual potential in their fellow eye. Causes of loss of vision in the fellow eye were phthisis bulbi following injury and surgery for repair (n = 2), RD (n = 7), adherent leucoma (n = 1), optic atrophy (n = 1).

Table 1: Pre- intra- and postoperative variables

Variables	*Characteristics*	*Total (n = 51)* *No. of eyes (%)*	*One-eyed (n = 11)* *No. of eyes (%)*
	Preoperative		
PVR	D1	25 (49.0)	
	D2	14 (27.5)	
	D3	12 (23.5)	
Lens status	Clear	08 (15.7)	02 (18.2)
	Cataract	17 (33.3)	03 (27.3)
	Pseudophakia	18 (35.3)	04 (36.4)
	Aphakia	08 (15.7)	02 (18.2)
Prior surgeries	Scleral buckling	10 (19.6)	02 (18.2)
	Vitrectomy (once)	06 (11.8)	03 (27.3)
	Vitrectomy (twice)	01 (01.9)	
	Keratoplasty	01 (01.9)	01 (09.0)
	Cataract surgery	26 (51.0)	
	Silicone oil tamponade	03 (05.9)	02 (18.2)
	Intraoperative		
Adjunct procedure	Band encirclage	41 (80.4)	
	Pars-plana lensectomy	03 (05.9)	02 (18.2)
	Phacoemulsification	07 (13.7)	
	IOL removal	01 (01.9)	
	Silicone oil removal	03 (05.9)	02 (18.2)
	Membrane peeling	51(100)	11 (100)
	Silicone oil tamponade	51 (100)	11 (100)
Retinectomy size	180-270 (degree)	28 (54.9)	07 (63.6)
	> 270 (degree)	23 (45.1)	04 (36.4)
	Postoperative		
Retinal status	Complete attachment	31 (60.8)	07 (63.6)
	Partially attachment	13 (25.5)	02 (18.2)
	Unsettled retina	07 (13.7)	02 (18.2)
Resurgery	1	03 (05.9)	02 (18.2)
	>1	01 (01.9)	
SOR	—	07 (13.7)	02 (18.2)
Complication	Recurrent PVR	05 (09.8)	02 (18.2)
	Silicone keratopathy	01 (01.9)	
	Hypotony	03 (05.9)	01 (09.0)
	Secondary glaucoma	03 (05.9)	
	ERM	02 (03.9)	
	Optic disk pallor	04 (07.8)	

Table 2: Pre- and postoperative BCVA

Best corrected visual acuity	*Total (n = 51)*		*One eyed (n = 11)*	
	Preoperative	*Postoperative*	*Preoperative*	*Postoperative*
	No. of eyes (%)	*No. of eyes (%)*	*No. of eyes (%)*	*No. of eyes (%)*
No PL	—	—	—	—
(PLPR)	41 (80.4)	21 (41.3)	10 (90.9)	05 (45.5)
(HM)	06 (11.8)	09 (17.7)	01 (9.01)	01 (09.0)
(20/2000)	04 (07.8)	06 (11.7)	—	03 (27.2)
(20/800)	—	05 (09.8)	—	02 (18.2)
(20/400)	—	04 (07.8)	—	—
(20/320)	—	01 (01.9)	—	—
(20/200)	—	05 (09.8)	—	—

At final follow-up, seven (63.6%) eyes had complete retinal attachment, while two each had partial reattachment and unsettled retina respectively. The details of presenting and final BCVA in the subgroup of one-eyed patients are given in Table 2. In this subgroup, mean preoperative BCVA was 3.0 and mean final acquity was 2.47 ± 0.62 with mean improvement of 0.52 ± 0.62 and was found to be statistically significant ($p = 0.038$) using Wilcoxon signed ranks test (Table 3). At final follow-up, six (54.5%) eyes showed improvement, four (36.4%) eyes maintained, while one (9.1%) eye had deterioration from their presenting visual acquity (Fig. 1). Five (45.4%) patients achieved ambulatory vision of ≥ 0.02.

Table 3: Mean improvement in BCVA

BCVA	Mean preoperative	Mean postoperative	Mean difference	p-value	Statistical significance
Total	2.92 ± 0.27	2.33 ± 0.84	0.59 ± 0.91	< 0.005	Highly significant
One eyed	3.0	2.47 ± 0.62	0.52 ± 0.62	0.038	Significant

DISCUSSION

Eyes with primary retinal detachment remain vulnerable to the dreaded complication of PVR, which has been shown to develop in 5.1 to 11.7% of such cases.[16-20] Ongoing research to prevent the development or recurrence of PVR using antineoplastic drugs such as 5-FU and daunorubicin is at an infantile stage, with no clear-cut indications or protocols and limited reported success rates.[21,22] Scleral buckling and peeling of the proliferative membranes, along with the use of PFCL are often not adequate to relieve retinal traction in advanced PVR.[1,8,23]

Relaxing retinectomies, first described by Machemer in 1981, are now considered as valuable tools in management of such challenging circumstances. Retinectomy is indicated when there are extensive epiretinal membrane formations, particularly strong membrane adhesions to retina or residual retinal traction following membrane dissection. It also enables the surgeon to tackle subretinal membranes by providing a direct access. In literature, postoperative complications after retinotomy and retinectomy were found to be common, including high rates of recurrent RD and reproliferation (17-48%),[1,2,6,10,23] resurgery (19-32%),[24,25] and hypotony (19-43%).[1,2,4,6,10,23] Silicon study (report 5, 1993)[27] concluded that eyes undergoing a vitrectomy for the first time for PVR could in most instances be successfully treated by conventional techniques, while retinotomy may be required more often in patients undergoing repeat vitreous surgery. These concerns that relaxing reinectomies may contribute to visual and anatomic failure led to recommendations that they be applied sparingly.[24-27]

Revolutionary advancements in vitreoretinal surgical techniques, particularly widespread availability and application of perflurocarbon liquids and wide angle viewing systems,[28] have aided in increasing the success of anatomical outcomes in surgeries for PVR. While the former aids in recognition and removal of epiretinal tractional sources and to manage the giant retinal tear created following a large retinectomy, the latter helps improve visualization, thus allowing better recognition of anterior tractions and surgical maneuverability in this area.

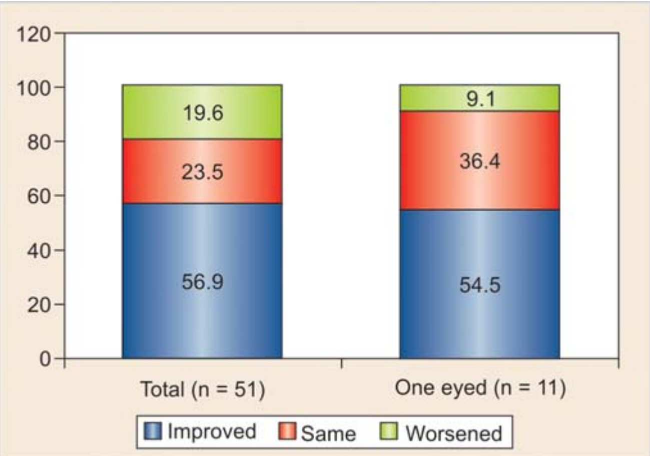

Fig. 1: Percentage change in BCVA

In our series of 51 eyes, final anatomic success was achieved in 83.72% with complete retinal reattachment in 58.38% eyes and partial retinal attachment in 25.6% eyes. In other reports of retinectomies, anatomic success has been found to range from 40 to 85%,[1,3-9,27,29] though our results cannot be directly compared with most previous studies due to their inclusion of variable severity and multiple etiologies of PVR and variable retinectomy sizes. Also, unlike our series, none of these studies have included exclusively PVR-D cases.

Various studies have reported that extent of retinectomy and the preoperative VA (albeit as surrogate markers of disease severity) are directly related to final VA.[2,3,24] Some reports, however, did not find any association between extent and location of retinectomy and visual prognosis.[1,8] In our study, 51.2% eyes showed improvement, 25.6% eyes maintained, while 23.2% eyes had deterioration from their presenting visual acquity. Vlassis et al[3] reported improved visual acuity in 45%, stabilization in 24% and worsening in 29% of cases of PVR C eyes. De silva et al[30] reported preserved or improved VA in 71% of their cases. In our series, 7% eyes had BCVA of 20/200, while 16.2% had BCVA of 5/200 or better, at final follow-up. In previous reports, vision of 5/200 or better has been achieved in 7 to 85% of eyes and 20/200 or better in 10 to 51% of eyes.[3-9,27-29] Morse et al[1] reported 29% of eyes achieving VA of 5/200, 17% had 20/200 or better and 20/100 or better in 5%, while Tseng et al[5] reported 67.3% cases achieving VA better than or equal to 5/200. Relatively less pre- and postoperative visual acuity in our series was attributed to advanced PVR.

Given the advanced pathology in our series, visual stabilization or improvement in approximates 76.8%, with almost 35% achieving ambulatory vision of 0.02 or better on logMAR suggest that surgical intervention in advanced PVR remains worthwhile, more so in cases of one-eyed patients. This is supported by recent work suggesting that surgery for advanced PVR is reasonably cost-effective as determined by cost per quality-adjusted life year.[31] In our study, 45.4% (5 out of 11) of one-eyed patients achieved ambulatory vision of 0.02 or better on logMAR. In addition, it has been reported that in patients with PVR in one eye, 50 to 74.3% of fellow eyes have a rhegmatogenous event (vision threatening pathology) resulting in profound loss of vision[32-34] and often the eye that was initially considered the worst seeing eye becomes the better-seeing eye (like spare tyre) if managed appropriately. This uncertain visual prognosis in the fellow eye is further evidence for the usefulness of intervention for advanced PVR despite modest final visual results of PVR surgery. So, the rationale for performing PVR surgery has been well established to conserve/regain vision at least better than ambulatory vision underexplained prognosis. Our results are encouraging, not only because of the rate of anatomic success in such high-grade PVR but also by affording significantly improved vision from baseline.

Hypotony and retinectomy: In our study, we did not find any correlation between retinectomy size and postoperative hypotony. Hypotony was observed in seven cases preoperatively and three cases postoperatively (6.97%) in our series. Of these, two eyes had redetachment and in one case hypotony developed after SOR. All the seven cases with preoperative hypotony achieved normal ocular tone after surgery. Etienne et al also found no association between IOP and extent of retinotomy, or anatomic success.[6] Hypotony was seen in 43% of reattached eyes in a series by Morse et al.[1] Alturki et al recorded hypotony in 40% of a series of eyes in which a 360° retinectomy was performed.[35] In the Silicone study, hypotony was more prevalent in eyes that had a retinectomy than in those that did not, and of those eyes that had a retinectomy, silicone oil was associated with a lower incidence of hypotony than gas during the first 6 months of follow-up.[27]

The physiologic basis for hypotony after retinectomy is not clearly defined but suggested mechanisms are secondary to facilitation of fluid transport by large areas of bare RPE after relaxing retinotomies, damage to the ciliary processes by anterior proliferation with subsequent hyposecretion, excessive retinal photocoagulation and retinocrepexy.[36] Diffuse anterior contraction has been reported as a significant predictor of postoperative hypotony regardless of the retinal status.[37] Federman et al reported 78% of preoperatively hypotonous eyes achieved normal IOP after surgery[23] and suggested that this may be due to the removal of anterior PVR membrane covering the pars plicata ciliary epithelium. We believe that severe anterior PVR with membrane covering the ciliary body and resulting in ciliary body detachment may be the primary mechanism of hypotony and meticulous removal of all anterior epiretinal membranes and usage of silicone oil as long-term tamponade could lower hypotony rates. The primary aim of retinectomy remains an adequate relief of traction and successful retinal reattachment. The size of retinectomy is balanced with this view, by limiting the retinectomy size to the minimum necessary in order to relieve traction on the retina and also to avoid hypotony.

A limiting factor within our data is that only seven eyes had undergone oil removal in this period which might have some bearing on the final outcomes. Silicone oil removal is commonly done after 3 to 6 months, if the retina is attached but in cases of advanced PVR it can be delayed for up to 12 to 14 months.[4,30,38] Kampik et al have reported better anatomical outcomes with prolonged duration of tamponade in cases of advanced PVR.[39] Since, all our cases had advanced PVR (PVR D), duration of tamponade was longer and silicone oil removal was considered after at least 1 year follow-up or earlier if there were complications.

Recurrent PVR in retinectomy: Haut et al and others [9,27,40] have reported severe folding of inferior retina in up to 16% of patients undergoing relaxing retinectomy and silicone oil insertion. Possible mechanisms of this complication could be persistent activation of PVR despite flattening of the retina in the early postoperative period or inadequate laser photocoagulation/tamponade. We did notice retinal crumpling in one case that underwent 360º of retinectomy out of 18 cases with retinectomy of ≥ 270º but none of our other cases showed severe retinal folding probably due to adequate relaxing retinectomy, 3 to 4 rows of 360º laser barrage and prone positioning till laser scars takes over.

With the advances in vitreoretinal surgical techniques it is possible to achieve successful anatomical outcomes even in patients with RRD associated with advanced PVR in a high number of cases. Previous studies have reported successful anatomical results but there was a heterogeneous selection of cases with regards to etiology, grading of PVR, size of retinectomy, etc. In order to reduce the influence of confounding variables, we included patients with RRD associated with PVR-D1 or more that underwent retinectomy of 180º or more. We found encouraging results in terms of anatomic success and significantly improved vision from baseline in such high- grade PVR. Further, maintenance or regaining of ambulatory vision, which is useful in one-eyed patients or in case of future catastrophe in the fellow eye was encouraging. We acknowledge that the retrospective nature of our study is a limitation. Further, it would also be useful to study results in this group of patients after silicon oil has been removed.

REFERENCES

1. Morse LS, McCuen BW 2nd, Machemer R. Relaxing retinotomies. Analysis of anatomic and visual results. Ophthalmology 1990;97:642-47.
2. Iverson DA, Ward TG, Blumenkranz MS. Indications and results of relaxing retinotomy. Ophthalmology 1990;97:1298-304.
3. Grigoropoulos VG, Benson S, Bunce C, Charteris DG. Functional outcome and prognostic factors in 304 eyes managed by retinectomy. Graefes Arch Clin Exp Ophthalmol 2007;245: 641-49.
4. Quiram PA, Gonzales CR, Hu W, Gupta A, Yoshizumi MO, Kreiger AE, et al. Outcomes of vitrectomy with inferior retinectomy in patients with recurrent rhegmatogenous retinal detachments and proliferative vitreoretinopathy. Ophthalmology 2006;113:2041-47.
5. Tseng JJ, Barile GR, Schiff WM, Akar Y, Vidne-Hay O, Chang S. Influence of relaxing retinotomy on surgical outcomes in proliferative vitreoretinopathy. Am J Ophthalmol 2005;140: 628-36.
6. Bovey EH, De Ancos E, Gonvers M. Retinotomies of 180 degree or more. Retina 1995;15:394-98.
7. Faude F, Lambert A, Wiedemann P. 360 degree retinectomy in severe anterior PVR and PDR. Int Ophthalmol 1998-1999; 22:119-23.
8. Han DP, Lewis MT, Kuhn EM, Abrams GW, Mieler WF, Williams GA, et al. Relaxing retinotomies and retinectomies. Surgical results and predictors of visual outcome. Arch Ophthalmol 1990;108:694-97.

9. Haut J, Monin C, Larricart P, van Effenterre G, Piaton JM, Flamand M. Study of a new series of large relaxing retinotomies. Ophthalmologica 1989;198:35-39.
10. Castellarin A, Grigorian R, Bhagat N, Del Priore L, Zarbin MA. Vitrectomy with silicone oil infusion in severe diabetic retinopathy. Br J Ophthalmol 2003;87:318-21.
11. Scott IU, Flynn HW Jr, Murray TG, Smiddy WE, Davis JL, Feuer WJ. Outcomes of complex retinal detachment repair using 1000 vs 5000-centistoke silicone oil. Arch Ophthalmol 2005;123:473-78.
12. Mason JO 3rd, Colagross CT, Haleman T, Fuller JJ, White MF, Feist RM, et al. Visual outcome and risk factors for light perception and no light perception vision after vitrectomy for diabetic retinopathy. Am J Ophthalmol 2005;140:231-35.
13. Zerrin Bayraktar, Ziya Kapran, Mustafa Mete, Tugrul Altan, Nur Acar, Yaprak Banu Ünver. Indications and results of pars plana vitrectomy in childhood. Journal of Retina-Vitreous 2005;13:283-87.
14. The classification of retinal detachment with proliferative vitreoretinopathy. Ophthalmology 1983;90:121-25.
15. Bourke RD, Cooling RJ. Vascular consequences of retinectomy. Arch Ophthalmol 1996;114:155-60.
16. Speicher MA, Fu AD, Martin JP, von Fricken MA. Primary vitrectomy alone for repair of retinal detachments following cataract surgery. Retina 2000;20:459-64.
17. Duquesne N, Bonnet M, Adeleine P. Preoperative vitreous hemorrhage associated with rhegmatogenous retinal detachment: A risk factor for postoperative proliferative vitreoretinopathy. Graefes Arch Clin Exp Ophthalmol 1996;234:677-82.
18. Girard P, Mimoun G, Karpouzas I, Montefiore G. Clinical risk factors for proliferative vitreoretinopathy after retinal detachment surgery. Retina 1994;14:417-24.
19. Bonnet M, Fleury J, Guenoun S, Yaniali A, Dumas C, Hajjar C. Cryopexy in primary rhegmatogenous retinal detachment: A risk factor for postoperative proliferative vitreoretinopathy. Graefes Arch Clin Exp Ophthalmol 1996;234:739-43.
20. Heimann H, Bornfeld N, Friedrichs W, Helbig H, Kellner U, Korra A, et al. Primary vitrectomy without scleral buckling for rhegmatogenous retinal detachment. Graefes Arch Clin Exp Ophthalmol 1996;234:561-68.
21. Garcia RA, Sanchez JG, Arevalo JF. Combined 5-fluorouracil, low-molecular-weight heparin, and silicone oil in the management of complicated retinal detachment with proliferative vitreoretinopathy grade C. Ophthalmic Surg Lasers Imaging 2007;38:276-82.
22. Creten O, Spileers W, Stalmans P. Systemic resorption of 5-fluorouracil used in infusion fluid during vitrectomy. Bull Soc Belge Ophtalmol 2007;303:37-41.
23. Federman JL, Eagle RC Jr. Extensive peripheral retinectomy combined with posterior 360 degree retinotomy for retinal reattachment in advanced proliferative vitreoretinopathy cases. Ophthalmology 1990;97:1305-20.
24. Lewis H, Aaberg TM, Abrams GW. Causes of failure after initial vitreoretinal surgery for severe proliferative vitreoretinopathy. Am J Ophthalmol 1991;111:8-14.
25. Lewis H, Aaberg TM. Causes of failure after repeat vitreoretinal surgery for recurrent proliferative vitreoretinopathy. Am J Ophthalmol 1991;111:15-19.
26. Lewis H, Burke JM, Abrams GW, Aaberg TM. Perisilicone proliferation after vitrectomy for proliferative vitreoretinopathy. Ophthalmology 1998;95:583-91.
27. Blumenkranz MS, Azen SP, Aaberg T, Boone DC, Lewis H, Radtke N, et al. Relaxing retinotomy with silicone oil or long-acting gas in eyes with severe proliferative vitreoretinopathy. Silicone Study Report 5. The Silicone Study Group. Am J Ophthalmol 1993;116:557-64.
28. Lesnoni G, Billi B, Rossi T, Stirpe M. The use of panoramic viewing system in relaxing retinotomy and retinectomy. Retina 1997;17:186-90.
29. Han DP, Rychwalski PJ, Mieler WF, Abrams GW. Management of complex retinal detachment with combined relaxing retinotomy and intravitreal perfluoro-n-octane injection. Am J Ophthalmol 1994;118:24-32.
30. de Silva DJ, Kwan A, Bunce C, Bainbridge J. Predicting visual outcome following retinectomy for retinal detachment. Br J Ophthalmol 2008;92:954-58.
31. Brown GC, Brown MM, Sharma S, Busbee B, Landy J. A cost-utility analysis of interventions for severe proliferative vitreoretinopathy. Am J Ophthalmol 2002;133:365-72.
32. Schwartz SD, Kreiger AE. Proliferative vitreoretinopathy: A natural history of the fellow eye. Ophthalmology 1998;105:785-88.
33. Gonzales CR, Gupta A, Schwartz SD, Kreiger AE. The fellow eye of patients with rhegmatogenous retinal detachment. Ophthalmology 2004;111:518-21.
34. Richter-Mueksch S, Kiss CG, Radner W, Binder S, Velikay-Parel M. Proliferative vitreoretinopathy—at what risk is the fellow eye? Wien Klin Wochenschr 2004;116:32-36.
35. Alturki WA, Peyman GA, Paris CL, Blinder KJ, Desai UR, Nelson NC Jr. Posterior relaxing retinotomies: Analysis of anatomic and visual results. Ophthalmic Surg 1992;23:685-88.
36. McCuen BW 2nd, Landers MB 3rd, Machemer R. The use of silicone oil following failed vitrectomy for retinal detachment with advanced proliferative vitreoretinopathy. Ophthalmology 1985;92:1029-34.
37. Barr CC, Lai MY, Lean JS, Linton KL, Trese M, Abrams G, et al. Postoperative intraocular pressure abnormalities in the Silicone Study. Silicone Study Report 4. Ophthalmology 1993;100:1629-35.
38. Falkner CI, Binder S, Kruger A. Outcome after silicone oil removal. Br J Ophthalmol 2001;85:1324-27.
39. Kampik A, Höing C, Heidenkummer HP. Problems and timing in the removal of silicone oil. Retina 1992;12(3 Suppl):S11-6.
40. Gupta B, Mokete B, Laidlaw DA, Williamson TH. Severe folding of the inferior retina after relaxing retinectomy for proliferative vitreoretinopathy. Eye 2008;22:1517-19.