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RETINAL DISORDERS

Three hundred and sixty degree retinotomy for retinal detachments with severe proliferative vitreoretinopathy

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Abstract
Aims To assess the anatomic and functional results of 360° retinotomy for rhegmatogenous retinal detachment (RD) with severe proliferative vitreoretinopathy (PVR).
Materials and methods Retrospective, non-comparative, interventional, case study of 20 consecutive patients. All surgical operations are as follows: vitrectomy, membrane peeling, PFCL, circumferential 360° retinotomy with anterior retinectomy, and silicone oil tamponade. The decision to pursue retinotomy was made during surgery after exploring all conventional techniques and after maximum membrane removal.
Results The mean number of previous interventions was 1.7 (median 2; range: 0–4). All retinas were reattached at the end of surgery. After 38 months of mean follow-up (range: 18–53 months) the complete retinal reattachment rate was 70 % (14/20). At the end of follow-up, four eyes (20 %) were enucleated and two patients are deceased. Silicone oil was removed in five eyes (25 %). Five eyes (25 %) developed corneal degeneration, four (20 %) rubeosis and one eye (5 %) presented an optic nerve atrophy. Final post-operative visual acuity in eyes with reattached retinas (n=14) was better or equal to 20/200 in two cases, counting fingers in six cases , hand movements in five cases and light perception in one case.
Conclusions Only two of 20 operated eyes (10 %) had visual acuity better or equal to 20/200, but only four eyes (20 %) were enucleated. The aim of 360° retinotomy is to avoid further surgery on already fragile and multi-operated eyes.

Keywords Retinotomy · Retinal detachment · PVR · Vitrectomy

Introduction

Proliferative vitreoretinopathy (PVR), a process of cellular proliferation and contractile preretinal membrane formation, remains the principal cause of failed surgery on retinal detachment (RD). The first description of relaxing retinotomy was presented by Machemer in 1979 in an eye with traumatic retinal incarceration [1]. Zivojnovic et al. improved the technique of retinotomy and retinectomy for the surgical treatment of proliferation and severe anterior traction [2]. Haut et al., in 1985, were the first to describe 360° retinotomy [3].

By definition, anterior PVR occurs anterior to the posterior insertion of the vitreous base. Three different tractional forces vectors contribute to anterior PVR, i.e., anteroposterior, circumferential, and perpendicular traction [4]. The membranes of posterior PVR can usually be surgically removed, hence relaxing retinotomy is rarely necessary. However, dissection of peripheral membranes in anterior PVR is more difficult to treat and frequently requires retinotomy. Consequently, relaxing retinotomy procedures have become important surgical adjuncts to vitrectomy for cases of RD complicated by PVR, when epiretinal membrane dissection and scleral buckling cannot relieve preretinal traction and retinal foreshortening. Indeed, the retina can only be reattached by retinotomy in these very complicated cases.

Meeting presentation A limited account of this study was presented at the Jules Gonin Club Meeting (2008).

Study performed at Hospices Civils de Lyon, Quai des Célestins, 69288 Lyon Cedex 02, France

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Few publications deal with complete 360° retinotomy [4–7]. In contrast, partial relaxing retinotomy is much more frequently described. Accordingly, the present report is a retrospective and non-comparative assessment of consecutive rhegmatogenous RD cases with severe anterior or posterior PVR treated by 360° retinotomy, with respect to anatomic and functional results.

Materials and methods

We retrospectively reviewed the records of 20 consecutive patients who underwent unilateral 360° retinotomy between March 2005 and November 2007, at the Croix-Rousse University Hospital, Lyon, France. Surgery was performed for complex rhegmatogenous RD characterized by severe anterior PVR, unresponsive to traditional methods.

All patients underwent an examination before and after surgery that included visual acuity testing, slit-lamp and fundus biomicroscopy, intraocular pressure (IOP) measurement. Baseline PVR (preoperative and especially intraoperative) was characterized by a wide-angle viewing system, and was graded according to the revised PVR classification proposed by Machemer et al. in 1991 [8]. The postoperative assessments included: retinal and macular reattachment, PVR grading, anterior segment status, silicone oil removed or not, final IOP, final visual acuity, and the number and details of re-operations.

Surgical procedures

Surgical procedures were performed by only one surgeon (LK). All operated eyes underwent standard three-port pars plana 20-G vitrectomy under conventional plano-convex and wide-field panoramic lenses with 360° scleral depressure. The lens was removed by phacoemulsification from all phakic patients, in order to perform complete anterior 20-G vitrectomy, and was always replaced by an intraocular lens positioned into the bag. In pseudophakic patients, the artificial lens was left in place. All visible posterior preretinal membranes were removed (Fig. 1), and perfluorodecalin was applied to assess residual tractional elements, then to stabilize the center of the retina during peripheral dissection of anterior PVR, and again during retinotomy.

The decision to pursue retinotomy was done during surgery after exploring all conventional techniques and after maximum membrane removal. Before performing 360° retinotomy and retinectomy, an attempt was made to reattach the retina by limited retinotomy. Prior to retinotomy, to prevent retinal haemorrhage while cutting the retina, we used diathermy. All retinotomies were performed as peripherally as possible. Retinotomy was followed by retinectomy of non-functional anterior retina. An additional perfluorodecalin injection was then made to completely flatten the remaining retina, which was subsequently secured by three to four encircling rows of laser photocoagulation (intermittent setting) applied along the rim of the remaining posterior retina. All patients received a 1,000-centistoke silicone oil tamponade after a perfluorodecalin/silicone exchange. No adjuvant pharmacologic agents were used during this surgical procedure, and no scleral buckles were added to the 360° retinotomy.

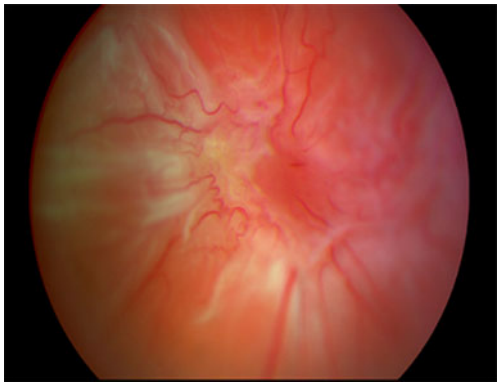

Fig. 1 Posterior PVR with diffuse contractions in 73-year-old patient. Confluent irregular retinal folds in posterior retina, around an invisible optic disc

Results

A summary of the general characteristics and preoperative ophthalmologic findings for the 20 operated patients is shown in Table 1. Rhegmatogenous retinal detachment is the only etiology in all these cases. The mean number of previous interventions was 1.7 (median 2; range: 0–4). Nine out of 20 patients had had a sectoral scleral buckle in a previous surgery. The average duration of PVR was 13.7 weeks (median 12; range: 4–28 weeks). Preoperative visual acuity ranged from counting fingers to no light perception.

At the end of surgery the retina was reattached in all 20 eyes. After 38 months of mean follow-up (range: 18–53 months), 4/20 (20 %) eyes were enucleated: 2/20 (10 %) for phthysis bulbi and uncontrolled pain and 2/20 (10 %) for persistent non operative RD. Two patients are deceased. The complete retinal reattachment rate was 70 % (14/20) (Fig. 2). Macular ectopia was noted in three of the 14 patients with reattached retina. None of them complained of diplopia.

Recurrent postoperative PVR was observed in seven eyes (35 %), characterized by macular pucker and/or epiretinal membrane formation located inside the retina in two cases

Table 1 General characteristics and preoperative ophthalmological findings in 20 patients

Characteristics	Value
General characteristics	
Age at the diagnosis of RD (years)	
Range	25–78
Median	64
Mean	58
Sex, *n* (%)	
Male	17 (85)
Female	3 (15)
Preoperative ophthalmological findings	
Previous surgery for RD	
Range	0–4
Median	2
Mean	1.7
High myopia (AL>26 mm), n (%)	5 (25)
Visual acuity, *n* (%)	
No light perceptions	2 (10)
Light perceptions	7 (35)
Hand movements	9 (45)
Count fingers	2 (10)
Phakics/pseudophakics/aphakic, *n* (%)	11 (55)/8 (40)/1 (5)
Number of holes, median (range)	2 (1–6)

RD retinal detachment; *AL* axial length; *PVR* proliferative vitreoretinopathy

(10 %), and just at the edges of the retinotomy towards the periphery in five cases (25 %) (Fig. 3). However, anatomical failure (RD recurrence) was noted in only two patients (10 %). PVR sample was taken from one patient for pathologic examination: only fibrovascular tissue was found, without any retinal tissue.

Silicone oil was removed from five of the 20 operated eyes (25 %) at the end of the follow-up period, in this group,

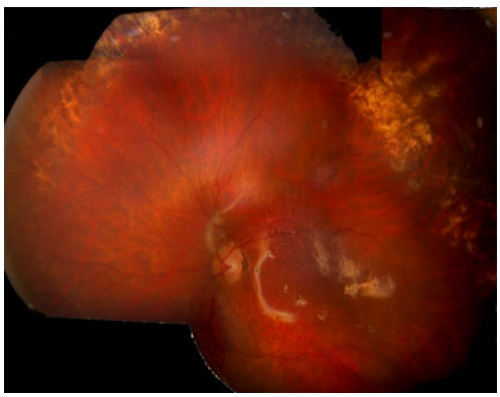

Fig. 2 Fundus photographic montage in patient at 4 months after surgery. Retinal reattachment under silicone oil. Scars of encircling rows of laser photocoagulation and limits of retinotomy

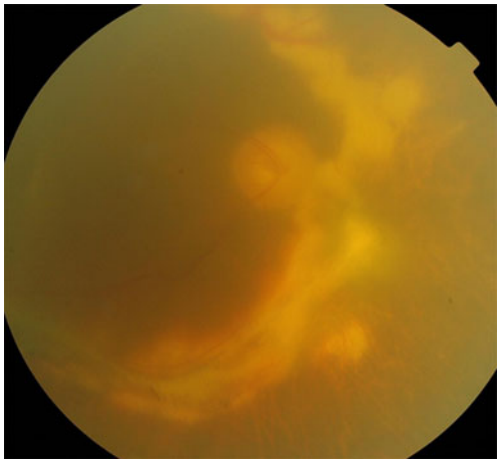

Fig. 3 Fifty-five-year-old female. Recurrent postoperative PVR located at the edges of the retinotomy, without RD recurrence. *VA* hand movements

two eyes had visual acuity better or equal to 20/200, and three eyes could count fingers. As remarked, 5/20 eyes (25 %) developed corneal decompensation characterized by stromal oedema and band keratopathy, 4/20 (20 %) rubeosis and 1/20 (5 %) presented an optic nerve atrophy (Table 2).

After 360° retinotomy, 10/20 eyes (50 %) required further operations, i.e., four had enucleation for recurrent RD and painful phthisis, one more vitrectomy for PVR peeling and silicone exchange for macular "pucker" without RD, and five silicone oil removal.

At the end of follow-up, silicone oil was not removed in 11 patients because of various contraindications: severe corneal decompensation ($n=5$), rubeosis ($n=4$) and/or hypotony(4). The bubbles of silicone oil in the anterior chamber were noted in four eyes.

Table 2 Clinical features at final assessment

Clinical features	Value
Reattached retina, *n* (%)	14 (70)
Silicone removal, *n* (%)	5 (25)
Iris rubeosis, *n* (%)	4 (20)
Corneal dystrophy, *n* (%)	5 (25)
Phtysis bulbi, *n* (%)	2 (10)
Enucleation, *n* (%)	4 (20)
Final VA in the reattached retina ($n=14$)	
Light perceptions	1
Hand movements	5
Count fingers	6
≥ 20/200	2
Final IOP ($n=14$): mean (range) mmHg	7.7(3–18)

VA visual acuity; *IOP* intraocular pressure

Postoperative hemorrhage and endophthalmitis were not observed.

Final post-operative visual acuity in eyes with reattached retinas (n=14) was better or equal to 20/200 in two cases, counting fingers in six cases , hand movements in five cases and light perception in one case.

Discussion

Severe anterior traction in PVR is still the most difficult surgical problem in RD. Retinotomy is a useful surgical technique in the management of complex retinal detachments with PVR when other procedures, including membrane peeling and scleral buckling, have failed [1, 5, 6, 9–12]. In the present study, the surgical indication was rhegmatogenous RD complicated by anterior and posterior PVR, with shortening of the retina preventing it from conforming to the posterior ocular contour. The condition necessitated 360° retinotomy in order to re-attach the retina.

Most published accounts of recurrent RD associated with advanced PVR subsequently treated by retinotomy are not easily compared because of differences in etiology, severity of PVR, location, and degree of retinotomy (45° to 360°), and removal, or not, of silicone oil. Nonetheless, less extensive retinotomies appear to result in better visual and anatomic prognosis. To our knowledge, few publications have dealt with 360° retinotomy [4–7]. In most cases, retinotomy was indicated when eyes had undergone at least one unsuccessful vitrectomy. The Silicone Study Group reported 19 % primary >180° retinotomy in non-vitrectomized eyes with RD with severe PVR [13], and the study by Faude et al. reported 15 % of primary 360° retinotomy [7].

Amongst the cases reported here, the final complete retinal reattachment rate was 70 %. The best visual acuity was 40/200, but 2/20 eyes (10 %) had visual acuity better or equal to 20/200, and 6/20 (30 %) eyes could count fingers. These results are comparable to those reported by other 360° retinotomy studies [5–7]. Therefore, it is possible to obtain a useful functional outcome from retinectomy, despite advanced pathology and often multiple surgeries.

The application of perfluorodecalin after a complete vitrectomy makes it possible to stabilize the center of the retina and to limit its rotation during the retinotomy. However, macular ectopia was observed in three patients after surgery. Final VA in these patients was limited to hand movements, and none of them complained of diplopia. Therefore, an orthoptic assessment was not performed.

Our PVR recurrence rate after surgery was about 35 %, and RD recurrence 10 %. This was located inside the retina (10 %) or just at the edge of remaining retina (25 %), with bridges stretching towards the periphery. Pathologic examination of PVR sample performed in one patient found fibrovascular tissue without any retinal tissue. Of course, non-functional peripheral retina should be removed, both to decrease reproliferation from the anterior retina [14] and to prevent retinal and iris neovascularization (and risk of neovascular glaucoma), in addition to traction on the ciliary body [15]. It should be remarked that cell proliferation occurred despite the foregoing precautions. Indeed, various studies dealing with RD and severe anterior PVR have noted a relatively homogeneous and stable post-surgical PVR recurrence (20–50 %), comparable to our rate [5–7, 16–19]. Finally, it would appear that the recurrence rate of PVR associated with severe RD remains stable, despite meticulous surgery, and that pharmacologic supplements might improve outcomes [20].

Ten eyes required or benefited from further surgery involving enucleation, surgery for recurrent PVR, and silicone oil removal. Silicone oil tamponade reduces the development of severe hypotony [7, 13, 21]. The main indications for removing silicone oil in our series was the anatomic successful of the surgery in three eyes with VA better then hand movements and without hypotony, and the occurrence of persistent stromal oedema in two eyes. This was performed within 4 to 6 months: only one eye was normotensive after silicone oil removal, and visual acuity decreased in one patient as a result of chronic hypotony and no further surgery was performed. In the published literature, in case of 360° retinotomy, silicone was not removed [4–7]. Indeed, silicone oil fillings reduce the frequency of hypotony, and may avoid phthisis [13, 21]. Thus, in order to prevent phthisis (or less severe chronic hypotony) and possible redetachment, some authors suggest deferring silicone oil removal in severe cases while continuing to control IOP, corneal decompensation, and cataract [22, 23].

Previous studies reported 15–40 % hypotony rates after 360° retinotomy [5–7]. Diffuse anterior contraction may be a significant predictor of postoperative hypotony, regardless of retinal status [21]. The primary mechanism of hypotony is severe anterior PVR with the membrane covering the ciliary body, resulting in ciliary body detachment [12]. So it appears that severe damage to the ciliary body, by pathology or repeated surgery, may result in hyposecretion and subsequent hypotony [14, 21]. Here we should point out that eyes with hypotony occurred in patients whose visual acuity did not improve, who had the longest PVR history (two patients with 20 and 25 weeks) and the highest number of surgical interventions before retinotomy. Therefore, we hypothesize that hypotony after surgery reflects the underlying extent of the pathology, and not the extent of retinectomy itself as suggested by other authors [7, 12, 16, 18], or these are simply risk markers related to each other for the same pathology (the greater the severity of PVR, the greater the surface of retinectomy and the greater the hypotony).

The purpose of this study was to evaluate the anatomic and functional outcomes of circular anterior retinotomy performed for severe rhegmatogenous RD with advanced anterior PVR, considered as untreatable, in order to inform patients about available therapeutic options. We are conscious of the limitations of the study, such as its retrospective design, non-comparative nature, and non-randomized structure. Moreover, the number of patients included is low, because such a surgically aggressive approach is rare. Nonetheless, the present study shows that repairing advanced anterior PVR and RD by 360° retinotomy can lead to encouraging anatomic and functional outcomes, with recovery of a useful vision, but also frequent and severe, but not disproportionate, complications. According to the literature, the mean visual field of patients with visual acuity better than "counting fingers" extends from 29° nasally to 38° temporally. Our results, and other published findings, showed a real benefit from operating these patients, because no one can be certain of what might happen to the remaining eye, especially as patients with unilateral PVR are at 50 % risk for vision-threatening pathology in the second eye within 10 years [24, 25]. The eye relegated to 'back-up' status may become the eye with better sight. Moreover, surgery for advanced PVR is reasonably cost-effective, as determined by cost per quality-adjusted life year (QALY) [26]. Accordingly, retinotomy for advanced PVR becomes a valid option and its promotion for these patients a justified aim, even though most of them will need long-term care for complications, as silicone withdrawal will never be possible. As always, of course, patient circumstances, general health, and expected benefit from successful surgery should be taken into account when evaluating the potential gain in quality of life.

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