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Outcome of temporary silicone oil tamponade in complex rhegmatogenous retinal detachment

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PURPOSE. To evaluate the anatomic and visual outcomes and complications of temporary silicone oil (SO) retinal tamponade in patients with complex rhegmatogenous retinal detachments (RD).

METHODS. The retrospective study included 100 eyes of 93 consecutive patients. Indications for the use of SO were proliferative vitreoretinopathy (PVR) (30 eyes), difficult RD (30 eyes), giant retinal tears (17 eyes), RD after penetrating trauma (14 eyes), and macular holes in highly myopic eyes (9 eyes). Vitrectomy surgery was performed with 5000-centistoke SO as the retinal tamponade. All eyes underwent prophylactic 360° retinopexy at the time of the retinal reattachment operation. The mean duration of SO tamponade was 26.4 weeks, with a mean follow-up of 67.5 weeks after removal of SO.

RESULTS. In 6 of 100 eyes (6%), the retina redetached after removal of SO. Including the successfully reoperated eyes, the final anatomic success rate was 96%. Other complications were cataract (61%), increased intraocular pressure (13%), hypotony (4%), keratopathy (4%), intravitreal hemorrhage (1%), and suprachoroidal hemorrhage (1%). Correspondence analysis demonstrated that redetatchment and hypotony were associated with PVR and trauma. Overall, good visual outcome (20/200 or better) was achieved in 51% of the whole study group, and in 70.6% of eyes with giant tears, 62.1% of eyes with difficult RD, 44.8% of eyes with PVR, 33.3% of eyes with macular holes, and 28.6% of eyes with trauma ($p=0.0382$). Logistic regression analysis identified initial visual acuity of 20/200 or better as a factor associated with good visual outcome and occurrence of retinal redetachment/hypotony and old age (≥50 years) as factors negatively associated with good visual outcome.

CONCLUSIONS. The low redetachment rate might be due to prophylactic 360° retinopexy. Giant tears had the best visual outcome. Redetachment/hypotony had a negative impact on achievement of good visual outcome and were associated with PVR and trauma. (Eur J Ophthalmol 2003; 13: 474-81)

KEY WORDS. Silicone oil, Silicone oil removal, Retinal detachment, Vitrectomy, Correspondence analysis

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INTRODUCTION

Silicone oil (SO) injection combined with pars plana vitrectomy (PPV) – a technique introduced in the 1960s by Cibis and associates (1), revived by Scott in 1975 (2), and modified by Zivojnovic et al in 1982 (3) – has become a standard technique and improves the prognosis of complex retinal detachments (RD) associated with proliferative vitreoretinopathy (PVR), giant retinal tears, proliferative diabetic retinopathy (PDR), or ocular trauma. The Silicone Oil Study showed that among eyes with complex RD associated with advanced grades of PVR, retinal reattachment rates, visual acuity (VA) outcomes, and complication rates were superior with SO compared to sulphur hexafluoride (SF_6) gas as a retinal tamponade (4), and results using SO or perfluoropropane (C_3F_8) gas were similar (5). However, SO leads to long-term complications, particularly cataract, glaucoma, keratopathy, and emulsification (6-8). Most of these complications are, at least in part, related to the length of time that oil is retained in the eye. In 1985, Gonvers (9) introduced the concept of SO as a temporary tamponade agent. As a consequence, most physicians now aim to remove the oil as the second stage of a planned two-stage procedure after a stable anatomic and functional status has been achieved (10-20). The Silicone Study Report 6 (16) showed that removal of SO in anatomically successfully operated eyes for severe PVR significantly increases the likelihood of improved VA. The purpose of the present study was to evaluate the anatomic and VA outcomes and complications associated with the use of temporary SO retinal tamponade in the management of complex rhegmatogenous RD.

MATERIALS AND METHODS

We retrospectively reviewed the medical records of 100 eyes of 93 consecutive patients who had rhegmatogenous RD and underwent temporary SO endotamponade between 1995 and 2001. The cases were identified by review of surgical records. All surgery was performed by one surgeon (A.M.A.). This series included 75 male patients (80.6%) and 18 female patients (19.4%). The mean age (±SD) of the patients at the time of surgery was 35 ± 16.8 years (range, 8.5 to 72 years).

The indications for the use of SO were advanced PVR (30 eyes), difficult cases of RD (30 eyes), giant retinal tears (17 eyes), RD after penetrating trauma (14 eyes), and RD due to macular holes in highly myopic eyes with posterior staphyloma (9 eyes). The PVR grading of our cases was done according to the Retina Society Classification (21). PVR was graded as C2 in 16 eyes, C3 in 5 eyes, D1 in 5 eyes, and D2 in 4 eyes. The difficult cases of RD included Stickler vitreoretinal dystrophy (5 eyes), RD associated with choroidal detachment (4 eyes), recurrent RD associated with suprachoroidal hemorrhage (3 eyes), and RD due to multiple posterior breaks located in different quadrants (18 eyes). The eyes with RD after penetrating trauma included 8 eyes that had undergone a previous PPV to remove intraocular foreign bodies, which were associated with endophthalmitis in 3 eyes, and 6 eyes with penetrating trauma without retained foreign bodies. All post-traumatic cases had rhegmatogenous RD, which was complicated by severe PVR (Grade D) in 6 eyes. All eyes with PVR had posterior segment intraocular foreign body injuries.

All eyes had been filled with highly purified SO with a viscosity of 5000 centistokes. Depending on the intraoperative situation, additional procedures performed during PPV included lensectomy, epiretinal membrane peeling where appropriate, use of an encircling band in all eyes, use of additional encircling buckles in PVR cases, relaxing retinotomies (six eyes), use of perfluorocarbon liquids (PFCL) in all eyes, fluid–silicone exchange using an automatic pump, and chorioretinal adhesion by transscleral cryotherapy or endolaser photocoagulation applied around all retinal breaks and along retinotomy edges. All the eyes underwent prophylactic 360° retinopexy using indirect laser or transscleral cryotherapy at the time of the retinal reattachment operation. The treatment was applied as a continuous band on the encircling buckle and posterior to the buckle. At the time of SO injection, 28 eyes underwent lensectomy, 18 eyes were aphakic, 8 eyes were pseudophakic, and 46 eyes were phakic. As a standard procedure in our clinic, aphakic eyes received inferior peripheral iridectomies to prevent pupillary block glaucoma. Tissue plasminogen activator (tPA) (25 µg in 0.1 ml) was injected using a 27-gauge needle into the anterior chamber of eyes in which fibrin occluded the inferior peripheral iridectomy. Injection of tPA was performed 3 to 5 days postoperatively.

The duration of SO tamponade ranged from 2 weeks to 324 weeks, with a mean ± SD of 26.4 ± 43.4 weeks (median, 16 weeks). The criterion to remove the SO was a stable ocular situation with successful retinal reattachment. In all patients, SO removal was performed under general anesthesia in vitrectomy technique. The fluid was removed with a 19-gauge needle connected to the vacuum pump. Thirty-six eyes (36%) required additional vitreoretinal procedures at the time of SO removal. These included peeling of epiretinal membranes (ERM) combined with additional laser photocoagulation and 25% SF_6-air mixture gas tamponade in 29 eyes, and additional laser photocoagulation and the use of SF_6 gas tamponade in 7 eyes. Fundi were examined by indirect ophthalmoscopy at the end of the procedure in order to confirm that the retina remained attached and that no large SO bubbles remained in the vitreous cavity.

All patients had ocular examinations before SO removal, postoperatively, and at each follow-up visit. These examinations included best-corrected VA testing using a Snellen eye chart, measurement of intraocular pressure, slit-lamp biomicroscopy, and fundus control with binocular indirect ophthalmoscopy. The mean ± SD follow-up period after removal of SO was 67.5 ± 64.7 weeks, ranging from 8 weeks to 416 weeks (median, 40 weeks).

STATISTICAL METHODS

The statistical methods used included the chi-square test, Student t-test, correspondence analysis (CA), and logistic regression analysis. The chi-square test was used to compare associations between two categorical variables. Student t-test was used to compare two proportions relating to the same sample. Logistic regression was used to identify factors that could predict good visual outcome. CA was used to investigate the association between the indications for the use of SO and the incidence of complications after temporary SO tamponade. CA graphical methods were used because the data were too sparse to justify application of the chi-square test. On a CA graph with x-axis and y-axis, row and column categories in the same quadrant indicate association. On a one-axis CA graph, association is judged on proximity of a row and column category. In either case, the graph should represent at least 90% of total inertia (information) to be considered appropriately depicting the associations inherent in the original table of raw data. Value of total inertia represented on each axis is usually printed at the bottom of the graph. Programs CA and LR from BMDP statistical software were used to conduct the CA and logistic regression, respectively

RESULTS

The retina remained attached after removal of SO in 94 of the 100 eyes (94%) included in the study. In 6 eyes (6%), the retina redetached after removal of SO. No redetachment was seen in the 17 eyes with giant retinal tears; 2 of 9 eyes (22%) with macular holes, 1 of 14 eyes (7%) with RD after penetrating trauma, 2 of 30 eyes (6.6%) with PVR, and 1 of 30 eyes (3.3%) with difficult RD developed retinal redetachment after removal of SO. Recurrence of RD was observed at 1, 2, 6, 11, 12, and 48 months after removal of SO.

The cause of the redetachment in the first three eyes was the development of severe posterior PVR. The indications for the use of SO in these three eyes were advanced PVR in a 10-year-old patient with Stickler vitreoretinal dystrophy, advanced PVR in a 19-year-old patient, and RD after severe penetrating trauma in a 10-year-old patient. The detachment in these three eyes was considered inoperable. Reopening of the previous macular hole at 11 and 12 months, respectively, was the cause of the redetachment in two eyes. The retina was reattached in these eyes after SO injection and endophotocoagulation. The last patient was a 12-year-old patient with Stickler vitreoretinal dystrophy who developed new multiple horseshoe retinal breaks posterior to the previous cryopexy related to detachment of the residual vitreous. The retina was reattached using revision of vitrectomy, injection of PFCL, endophotocoagulation, and SO injection. In this eye and the two eyes with macular hole, the retina remained reattached following SO removal.

Intraocular pressure greater than 21 mm Hg after SO removal was noted in 13 eyes (13%). The intraocular pressure could be normalized with local therapy in 12 eyes. One patient required additional surgery. This patient had angle recession glaucoma prior to SO injection. Of 46 eyes that were aphakic or underwent lensectomy at the time of SO injection, 6 (13%) re-

quired treatment for glaucoma, and of 54 eyes that were phakic or pseudophakic at the time of SO injection, 7 (12.9%) required treatment for glaucoma; the difference was not significant (p=0.8743). Hypotony (5 mm Hg or less) occurred in 4 eyes (4%) with attached retinae. Two of these eyes became phthisic soon after oil removal and one eye developed chorioretinal folds; these eyes required SO reinjection. The indications for the use of SO in these eyes were RD after penetrating trauma in three eyes; two of these three eyes developed the RD after PPV to treat posttraumatic endophthalmitis. The fourth eye had advanced PVR and had relaxing retinotomy.

Of the 46 phakic eyes, 28 (61%) developed increasing lens opacities during the follow-up period. In eight eyes, cataract extraction and implantation of a posterior chamber lens was performed. Keratopathy was present in 4 eyes (4%), two pseudophakic and two aphakic. Other complications were intravitreal hemorrhage in 1 eye (1%) and suprachoroidal hemorrhage in 1 eye (1%). All hemorrhages cleared spontaneously without requiring further surgical intervention.

We used CA graphical methods to study the associations between the indications for the use of temporary SO retinal tamponade and the incidence of complications. This analysis demonstrated that cataract and glaucoma were associated with RD due to macular holes and giant retinal tears, phthisis was associated with RD after penetrating trauma, and keratopathy was associated with difficult RD. The associations with redetachment/hypotony were indeterminate (Fig. 1a). When the associations were represented on one major axis (68.5% inertia), the incidence of redetachment/hypotony was associated with PVR and RD after penetrating trauma (Fig. 1b).

Final VA were unknown in two eyes. Of the 98 remaining eyes, 50 (51%) achieved VA of 20/200 or better, 36 (36.7%) had VA of counting fingers, and 12 (12.2%) had final VA of hand motions or worse. The poor visual outcome (hand motions or less) was related to the development of retinal redetachment (3 eyes), hypotony/phthisis (3 eyes), keratopathy (2 eyes), and cataract (1 eye). There were no complications in three eyes that were operated because of severe PVR. Postoperative VA improved in 61 eyes (62.2%), remained the same in 32 eyes (32.7%), and worsened in 5 eyes (5.1%) (Tab. I). The distribution of VA improved from presentation to final follow-up, with 9.2%

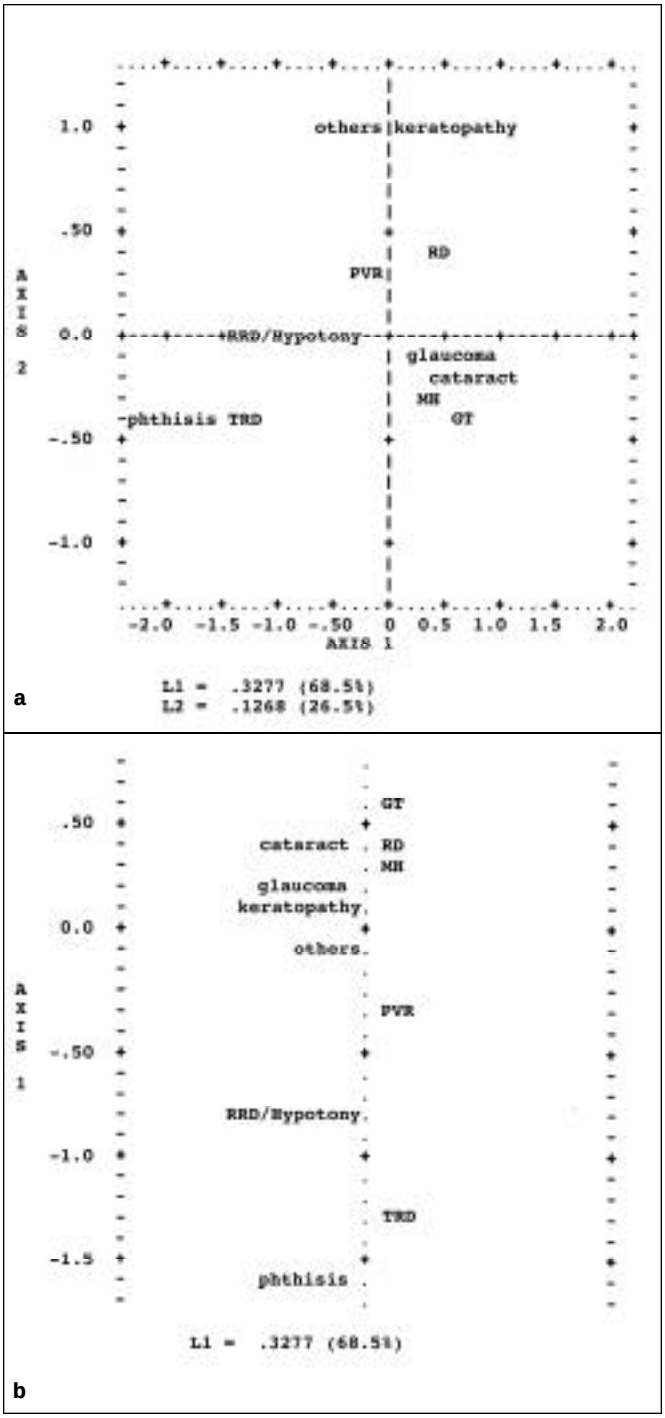

Fig. 1 - Correspondence analysis graphs. Two-axis graph **a)** and one major axis graph **b)** showing the association between the indications for the use of temporary silicone oil retinal tamponade and the incidence of complications.
RD = difficult retinal detachments; PVR = proliferative vitreoretinopathy; RRD = retinal redetachment; MH = retinal detachment due to macular holes; TRD = retinal detachment after penetrating trauma; GT = retinal detachment due to giant retinal tears.

TABLE I - INITIAL VISUAL ACUITY VERSUS VISUAL ACUITY AFTER TEMPORARY SILICONE OIL RETINAL TAMPONADE IN 98 EYES*

	Initial visual acuity			
Final visual acuity	**LP–HM**	**CF**	**≥20/200**	**Total**
≥20/200	17	25	8	50
CF	19	16	1	36
LP–HM	8	4	0	12
Total	44	45	9	98

The diagonal line represents the position at which initial and final visual acuities are equal. The numbers above the line represent an improvement in visual acuity, and the numbers below the line represent a decrease in visual acuity.

*Final visual acuities were unknown in two eyes.

LP = Light perception; HM = Hand motions; CF = Counting fingers

of eyes having 20/200 or better acuity at presentation compared with 51% of eyes by final follow-up ($p<0.001$, Student t-test), and 44.9% of eyes having hand motions or less at presentation as compared with 12.2% of eyes by final follow-up ($p<0.001$, Student t-test).

VA of 20/200 or better were achieved in 12 of 17 eyes (70.6%) with giant tears, 18 of 29 eyes (62.1%) with difficult RD, 13 of 29 eyes (44.8%) with PVR, 3 of 9 eyes (33.3%) with macular hole, and 4 of 14 eyes (28.6%) with RD after penetrating trauma. The result from the chi-square test was statistically significant ($p=0.0382$), indicating that achieving good visual outcome was significantly related to the indication for the use of SO. Eyes operated on for giant retinal tears with RD and eyes operated on for difficult RD had the best visual outcome, followed by eyes operated on for PVR, and finally eyes with macular holes with RD and eyes with RD after penetrating trauma.

Logistic regression analysis was conducted to determine which factors influenced or predicted good visual outcome (20/200 or better). The following predictor variables were included in the analysis: age, initial VA, initial intraocular pressure, indication for the use of SO, duration of SO tamponade, lens status, additional surgical procedures, development of complications, and duration of follow-up. Results from the logistic regression analysis identified older age (≥50 years) (coefficient = –1.286; odds ratio [OR] = 0.276; 95% confidence interval [CI] = 0.093 to 0.819), initial VA of 20/200 or better (coefficient = 2.648; OR = 14.1; 95% CI = 1.36 to 147), and development of retinal redetachment/hypotony (coefficient = –2.425; OR = 0.089; 95% CI = 0.01 to 0.803) to be the only covariates that significantly influenced achieving good visual outcome. The negative regression coefficients indicate that both older age (≥50 years) and occurrence of retinal redetachment/hypotony had negative impact on achieving good visual outcome. On the other hand, initial VA of 20/200 or better was associated with good visual outcome.

DISCUSSION

The removal of SO carries with it a definite ocular morbidity. The major complication of SO removal is retinal redetachment. The Silicone Study Group Report 6 found that removal of SO increases the chance of recurrent RD (16). The reported incidence of redetachment varies between 5% and 27.6% (10-20). This variation may reflect different patient selection, surgical techniques, and duration of follow-up after SO removal. Casswell and Gregor (11) reported retinal redetachment in 25% of eyes (PVR 30%, giant retinal tears 22%), Zilis et al (12) in 9% of eyes with PVR, Franks and Leaver (13) in 19% of eyes (giant retinal tears, posterior breaks, and PVR), Kampik et al (14) in 27.6% of eyes (PVR 44.4%, PDR 16.6%), Hutton et al (16) in 20% of eyes with PVR, Scholda et al (17) in 20.5% of eyes (PVR, PDR, trauma), Azen et al (18) in 5% of eyes (PDR, giant retinal tears, PVR, trauma, cytomegalovirus necrotizing retinitis), Jonas et al (19) in 25.3% of eyes (PVR, PDR), and Falkner et al (20) in 17.4% of eyes (PVR 16.5%, PDR 50%, trauma 0%). Proposed mechanisms for redetachment after oil removal include reopening of preexisting breaks that were tamponaded by the surface tension of SO due to insufficient retinopexy, formation of new breaks, or residual traction (16). The majority of recurrent RD after oil removal occurred within 6 months of oil removal and were especially frequent during the first 3 months (16). A recent study has suggested that retinal redetachment becomes unlikely 3 to 5 months after removal of SO and found that 71% of redetachments occurred in the first 50 days (22).

The rate of retinal redetachment after SO removal in our series was 6%, whereas the final anatomic failure was 3%. Possible explanations for the low redetachment rate in this study are as follows: 1) prophylactic 360° retinopexy that was applied in all eyes at the time of retinal reattachment operation. Two pilot studies suggested that the application of 360° laser retinopexy before removal of SO may be associated with a reduced incidence of retinal redetachment compared with that observed in patients who did not receive such prophylaxis (23, 24). In the first series (23), the incidence of redetachment was 7% in the treatment group compared with 25% in the controls. In the second series (24), the respective figures were 11% and 44%. More recently, Laidlaw et al (25) demonstrated that 360° prophylactic laser retinopexy was associated with a reduction from 26% to 14% in the incidence of redetachment after removal of SO; 2) meticulous peeling of ERM at the time of oil removal to eliminate residual preretinal traction, and endolaser photocoagulation augmentation of previous retinopexy and gas tamponade, if necessary; and 3) use of encircling buckles in eyes with PVR. Jonas et al (19) demonstrated that absence of an encircling band in eyes with PVR in which an inferior retinotomy had not been performed was a significant risk factor for retinal redetachment after removal of SO tamponade.

In the present series, 29 eyes (29%) required peeling of preretinal membranes at the time of SO removal. Zilis et al (12) noted proliferation of ERM in 38% of eyes with SO tamponade. They noted extensive ERM formation involving the posterior retina in three of five eyes that had detachment following SO removal and recommended the removal of these membranes before or during SO removal. Macular ERM peeling has been performed in 32.3% of the eyes that underwent SO removal in the Silicone Study (16).

In our study, 61% of phakic eyes at the time of SO injection developed cataract during the follow-up period. Rates of cataract were reported to range from 36.7% to 100% in other studies (9, 10, 13, 17, 20). Franks and Leaver (13) found that cataract formation was delayed by early removal of SO, but after 2 years the majority of eyes had undergone surgery for cataract or had developed lens opacities.

Keratopathy as a result of SO–corneal endothelial touch has remained a significant problem (26), although the addition of the inferior iridectomy (27) has lessened the likelihood of silicone–cornea contact. In the present study, 4 eyes (4%) had evidence of keratopathy at final follow-up. Rates of keratopathy were reported to range from 3.3% to 42.4% in other studies (11, 12, 16-18, 20). We recommend prompt SO removal when possible in the face of early corneal changes or SO–corneal touch.

Increased intraocular pressure requiring glaucoma treatment after SO removal was present at the last follow-up visit in 13 of 100 eyes (13%). The incidence of elevated intraocular pressure after SO removal was reported to range from 9% to 27.7% in other studies (12, 13, 17, 20). Previous reports demonstrated that aphakia was a significant risk factor for glaucoma following SO injection (10, 13). However, our results do not support aphakia as a risk factor for glaucoma after SO removal. Possible explanations are as follows: 1) all aphakic eyes received inferior peripheral iridectomy to prevent pupillary block glaucoma; 2) tPA was injected into the anterior chamber of eyes in which fibrin occluded the inferior peripheral iridectomy. Hypotony after SO removal occurred in four eyes with attached retinae (4%). Rates of hypotony were reported to range from 3.5% to 20% (9, 11, 12, 16-18, 20) after SO removal. In agreement with previous reports (9, 11, 16-18), the two causes of failure after the removal of SO in our study are retinal redetachment and hypotony. CA demonstrated that redetachment and hypotony were associated with PVR and RD after penetrating trauma.

In our study, 51% of the eyes achieved VA of 20/200 or better, and postoperative VA improved in 62.2% of the eyes, remained the same in 32.7% of the eyes, and worsened in 5.1% of the eyes. Zilis et al (12) reported VA of 20/200 or better in 47% of the eyes after SO removal. Postoperative VA improved in 44% of the eyes, remained the same in 33% of the eyes, and decreased in 24% of the eyes. Falkner et al (20) reported VA of 20/200 or better in 53% of the eyes following SO removal. Postoperative VA improved in 53.9% of the eyes, remained unchanged in 27% of the eyes, and worsened in 19.1% of the eyes. Jonas et al (19) reported VA of more than 20/200 in only 35% of the eyes after SO removal.

In the present study, after removal of SO, eyes operated on for giant retinal tears and eyes operated on for difficult RD had the best visual outcome, followed by eyes operated on for PVR, and finally eyes with

macular holes with RD and eyes with RD after penetrating trauma. Logistic regression analysis identified initial VA of 20/200 or better as a factor significantly associated with good visual outcome, and older age (≥50 years) and occurrence of retinal redetachment/hypotony as factors negatively associated with good visual outcome.

In conclusion, the low rate of retinal redetachment in this series might be due to prophylactic 360° retinopexy applied at the time of retinal reattachment operation, meticulous peeling of ERM at the time of oil removal, and the use of encircling buckles. The best visual outcome was achieved in eyes with RD due to giant tears; eyes with RD after penetrating trauma had the worst visual outcome. The complications of retinal redetachment/hypotony were associated with PVR and RD after penetrating trauma and had a negative impact on final visual outcome.

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