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# The Incidence of Rhegmatogenous Retinal Complications in Macular Surgery After Prophylactic Preoperative Laser Retinopexy

## A Retrospective Study

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**Abstract:** The aim of the study is to evaluate the clinical characteristics of intraoperative retinal breaks (RBs) and postoperative retinal detachment (RRD) in patients undergoing pars plana vitrectomy (PPV) for macular disorders, who were treated preoperatively with prophylactic peripheral laser retinopexy.

This observational cohort study comprised of 254 patients who underwent macular surgery and were preoperatively subjected to prophylactic laser retinopexy anterior to the equator. The main outcome measures were the incidence and characteristics of intraoperative RBs and postoperative RRD.

Intraoperative RBs occurred in 14 patients (5.5%). Ten patients presented a sclerotomy-related RB (3.9%) and 4 patients a nonsclerotomy-related RB (1.6%). Two patients showed postoperative RRD (0.7%). Neither of the 2 patients with postoperative RRD was macula-off at presentation: one of them was successfully operated on with scleral buckling and the other was managed by observation alone. A significantly increased risk for the intraoperative development of sclerotomy-related RB was found in 20-gauge PPV compared with 23/25-gauge PPV.

Preoperative prophylactic peripheral laser retinopexy does not guarantee the prevention of intraopertaive RBs or postoperative RRD. However, it might prevent the involvement of the macula when RRD occurs postoperatively.

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**Abbreviations**: BCVA = best corrected visual acuity, ERM = epiretinal membrane, MH = macular hole, OCT = ocular coherence tomography, PPLR = prophylactic peripheral laser retinopexy, PPV = pars plana vitrectomy, PVD = posterior vitreous detachment, RB = retinal break, RRD = rhegmatogenous retinal detachment.

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## INTRODUCTION

Visual outcomes are often improved after macular surgery, although complications still occur. Among the most significant complications, intraoperative retinal breaks (RBs) and postoperative rhegmatogenous retinal detachment (RRD) may result in visual loss. The reports available in the literature vary widely: the incidence of intraoperative RBs reported ranges from 0% to 24%, and that of postoperative RRD ranges from 0% to 16%.[1–23] These differences might be explained by the way the patients were selected. Some investigators evaluate the incidence of exclusively intraoperative breaks located in the periphery,[3,11] whereas others include only those caused by the induction of posterior vitreous detachment (PVD),[4,10] and still others only sclerotomy-related breaks.[23] The surgical technique used may also have an impact on this variation.[1–16] A further parameter that may affect the development of RB and RRD is the choice of instrumentation. Both from comparative studies[3–5,8,11,13–15] (20-gauge vs 23/25-gauge) and from noncomparative studies,[2,7,9,10,12] what seems to emerge is a lower number of intraoperative RBs in small-gauge pars plana vitrectomy (PPV) (although this number is not always significant[8]). However, the reduced incidence of RBs in small-gauge PPV is still associated with a relatively high incidence of postoperative RRD,[13,14] which involves the macula in nearly 50% of cases.[5,19] In the majority of cases, these were due to new RBs.[5,16,20]

Prophylactic measures such as scleral buckling, peripheral cryopexy, or intraoperative laser retinopexy have all been tried, yielding favorable results.[17–21,24] After performing intraoperative laser treatment, either for 360°[17,18,20] or around the sclerotomy site,[21] a significant reduction in postoperative RRD has been shown in laser-treated groups compared with nonlaser-treated groups.[17,18,20,21] In the small gauge era, some surgeons perform intraoperative prophylactic laser retinopexy treatment around the sclerotomy site,[22,23] showing a lower rate of postoperative RRD incidence compared with literature data (0% in the study by Tarantola et al[23] and 0.2% in the study by Parolini et al,[22] although in this latter study, PPV was performed for diverse indications). Few complications are associated with the use of laser retinopexy, and no additional risk of epiretinal membrane (ERM) formation or macular hole (MH) reopening has been found to occur.[18,22] Unfortunately, descriptions of the RRD characteristics, including its extension at presentation and the surgical technique adopted for repair, are lacking from the literature or are incomplete.[17,18,20–23]

At our institutions, it is a routine practice to treat patients undergoing macular surgery with preoperative prophylactic peripheral laser retinopexy (PPLR). Since, to our knowledge, this laser timing has never been adopted before, we studied the incidence and the characteristics of intraoperative RBs and postoperative RRD in macular surgery on such patients.

## METHODS

We reviewed the clinical records of patients who were treated with PPLR and underwent PPV for ERM or MH between January 2008 and March 2014, at the Ophthalmology Section of the Department of Medicine, Surgery and Neuroscience, University of Siena, Siena, Italy. The research adhered to the principles of the Declaration of Helsinki, and the institutional review board approved the study. Patients were treated after being informed of the nature of the treatment being offered, of the potential risks, benefits, adverse effects, possible treatment outcomes, and after having signed a consent form.

The inclusion criteria were as follows: ERM or full-thickness MH. PPLR was applied between 1.5 and 3 months before undergoing 20-gauge, 23-gauge, or 25-gauge vitrectomy.

The exclusion criteria were as follows: prior PPV, diabetic retinopathy, ocular trauma, ERM or MHs subjected to PPV without PPLR before surgery.

After all the exclusion criteria were applied, 254 eyes remained. Each patient underwent a complete preoperative evaluation, including the measurement of best corrected visual acuity (BCVA), anterior segment examination, dilated fundus examination using indirect ophthalmoscopy with scleral depression, and slit lamp biomicroscopic observation of the vitreous and the retina. The presence or absence of PVD was defined by biomicroscopic observation using a 90-diopter lens, B-scan ultrasound examination, and ocular coherence tomography (OCT) examination. All patients underwent OCT evaluation of the macular disorder. Thorough retinal periphery examination was regularly performed at follow-up visits. For postoperative evaluation, we considered the BCVA between 21 and 24 months after surgery.

All patients included in the study underwent 360° PPLR between 1.5 and 3 months before PPV. Using the VISULAS 532s (Zeiss, Germany) laser, 3 rows of laser spots were applied anterior to the equator using either a 3-mirror lens or a 160° contact lens. The spot diameter ranged from 100 to 200 microns, the treatment duration from 200 to 300 milliseconds, and the intensity from 200 to 300 milliwatts. The average number of spots was 410 (range 330–490).

In cases of MH and ERM where lattice degeneration or RB was diagnosed preoperatively, laser treatment was added at the time of PPLR.

Vitrectomy was performed by 2 authors (GMT, PE) assisted by a vitreoretinal fellow. Each surgeon chose 20-G PPV, 23-G PPV, or 25-G PPV for each procedure. Surgery was performed under either local or general anesthesia according to the patient's general conditions and preference. Three-port PPV was performed with one of 2 vitrectomy machines, both using only a Venturi pump (not a peristaltic one): either the Millenium (Bausch and Lomb, Rochester, NY) (cutting rate: 2500 cpm; vacuum: 250 mm Hg [20-gauge], 350 mm Hg [23-gauge], 450 mm Hg [450 mm Hg]) or Stellaris PC (Bausch and Lomb, Rochester, NY) (cutting rate: 5000 cpm; vacuum: 250 mm Hg [20-gauge], 350 mm Hg [23-gauge], 450 mm Hg [450 mm Hg]) vitrectomy instrument. The cutting rate and aspiration settings were the same for core and peripheral vitrectomy. The number of 20, 23, and 25-gauge cases was not significantly different between the 2 vitrectomy machines. A panoramic viewing system with wide-field contact lenses (Advanced Vitreal Instruments, NY) or a noncontact wide-field viewing system (Resight, Zeiss, Germany) was used. If there was no PVD, the induction of PVD was performed with the vitrectomy probe in the "cutter-off" mode, placed over the optic disc, elevating it anteriorly toward the anterior segment. The cortical vitreous was removed after PVD induction. ERM and internal limiting membrane peeling were performed using triamcinolone, indocyanine green, or membrane blue (DORC, Zuidland, The Netherlands). Peripheral vitrectomy was completed at the end of the procedure by performing scleral depression for 360°. Any newly discovered breaks were treated intraoperatively by laser photocoagulation. In every patient, fluid/air exchange was performed: the air was substituted with gas ($C_3F_8$ 11%) in MH cases and in the presence of any new intraoperative RB. In cases with coexisting cataract affecting visual acuity, phacoemulsification and intraocular lens implantation was performed before vitrectomy, through a corneal incision.

The medical records were reviewed and the following variables were collected: age at time of the procedure, sex, laterality, preoperative diagnosis, preoperative refraction, pre and postoperative visual acuity, lens status, the presence of lattice degeneration, prior retinal tears in the operative eye, PPV technique, preexisting or intraoperatively induced PVD, whether cataract surgery was undertaken at the time of vitrectomy, the presence/location of intraoperative RBs (sclerotomy/nonsclerotomy-related), the type of tamponing agent used, and the presence/characteristics of postoperative RRD. Preoperative refraction was not always available for pseudophakic eyes and was therefore not included in our analysis. For the purpose of the study, an intraoperative sclerotomy-related RB was defined as any break not present at preoperative examination, located anterior to the equator and within 1-clock-hour either side of the sclerotomy site. Any new intraoperative break located in other sites was considered not to be sclerotomy-related. Preoperative and intraoperative factors were analyzed for their possible association with the development/location of intraoperative RB and postoperative RRD.

For this purpose, the preoperative notes were reviewed together with postoperative data on day 1, day 7, day 15, month 1, month 2, month 3, and month 6. For eyes with longer follow-up periods, subsequent examination data were reviewed.

### Statistical Analysis

Multivariate stepwise logistic regression analysis was carried out to identify, among all the risk factors (independent variables), a statistically significant minimum subset of factors with the highest possible accuracy in predicting RRD, intraoperative RBs, and their sclerotomy or nonsclerotomy-related subtypes. Logistic discrimination is generally preferable to linear discrimination in small samples, especially when data distributions are suspected of being non-Gaussian.[25] The odds ratio (OR) was calculated for significant variables.

The statistical significance of the OR was assessed by evaluating the 95% confidence interval (CI) of sample estimates.

In case the type of PPV technique turned out to be a risk factor, we checked for any differences between the 20-gauge patient group and the small-gauge patient group. For this purpose, the quantitative variables were compared between groups using a 2-tailed Mann–Whitney test. The statistical association between each qualitative variable and the groups was evaluated using Fisher exact test. A $P$ value $<0.05$ was considered significant.

The SPSS software, version 10, was used for all statistical computations.

## RESULTS

A total of 254 patients were included in the study. Follow-up ranged from 21 to 84 months (mean: 44.3 months). There were 112 males (44%) and 142 females (56%), with a mean age of $67.60 \pm 6.8$ years. Axial length ranged between 21.37 and 25.48 mm (mean: 23.13 mm). One hundred forty-four patients underwent vitrectomy for ERM (56.6%) and 110 patients underwent vitrectomy for MH (43.3%). In particular, for ERM macular thickness ranged from 412 to 580 $\mu$m (mean: $481 \pm 55$ $\mu$m) and for MH 42 eyes were stage 2 MH, 41 eyes were stage 3 MH, and 27 eyes were stage 4 MH.

Preoperatively, 199 patients were phakic (78.3%) and 55 patients were pseudophakic (21.7%). 109 patients had 20-gauge PPV (42.9%) and 145 patients had 23/25-gauge PPV (57.1%). PVD induction was performed intraoperatively in 94 patients (37%); 140 had air tamponade (55.1%), whereas in 114 (44.9%), eyes gas tamponade was used. Thirteen patients underwent combined phacovitrectomy with Intraocular Lens implantation (5.1%). Fourteen patients (5.5%) experienced an intraoperative RB; in this group, 10 patients presented a sclerotomy-related RB (3.9%) and 4 patients a nonsclerotomy-related RB (1.6%). In 6 patients, intraoperative RBs occurred during ERM surgery, whereas in 8 patients, it occurred during MH surgery. Intraoperative RBs occurred in macular surgery with induced PVD in 5 patients, whereas in the other 9 patients, PVD was already present before surgery. Two patients showed macula-on postoperative RRD (0.7%) due to a nonsclerotomy-related RB. Of these, 1 RRD occurred after ERM surgery without PVD induction and air tamponade, whereas the other occurred after MH surgery with PVD induction and C3F8 11% tamponade. In both patients, no RB was present at the end of the macular surgery (Table 1).

In estimating the relative risk of retinal tear, the stepwise procedure for the logistic model design identified only the vitrectomy gauge as a predictive variable, whereas no other variables could be associated with RRD. In particular, a significantly increased risk for the intraoperative development of sclerotomy-related RB was found in 20-gauge PPV compared with 23/25-gauge PPV (OR 15.8, 95% CI 2.01–123.5). Both of the 2 postoperative RRDs occurred in the 20-gauge PPV group (1.8). No patient experienced postoperative RRD in the 23/25-gauge PPV group (0%) ($P = \mathrm{NS}$; Table 2).

**TABLE 1.** Clinical Characteristics of Patients at Study Entry

| | |
|---|---|
| Number of patients | 254 |
| Sex (M/F) | 112/142 (44%/56%) |
| Age, years | $67.60 \pm 6.8$ |
| Diagnosis | |
| Epiretinal membrane | 144 (56.6%) |
| Macular hole | 110 (43.3%) |
| Lens status | |
| Phakic | 199 (78.3%) |
| Pseudophakic | 55 (21.7%) |
| Vitrectomy gauge | |
| 20 G | 109 (42.9%) |
| 23–25 G | 145 (57.1%) |
| PVD induction | 94 (37%) |
| Tamponade | |
| Air | 140 (55.1%) |
| $C_3F_8$ | 114 (44.9%) |
| Retinal break | |
| Sclerotomy-related | 10 (3.9%) |
| Nonsclerotomy-related | 4 (1.6%) |
| Retinal detachment | |
| Sclerotomy-related | 0 (0%) |
| Nonsclerotomy-related | 2 (0.7%) |

### Postoperative Retinal Detachment Case Characteristics

The mean time to diagnosis of RRD in the 2 patients with this postoperative complication was 27.5 days (range 20–35 days). PPV was not combined with cataract surgery in either of the 2 patients.

One patient underwent PPV for ERM and the other for a MH. Both of the patients presented with RRD anterior to the equator, not affecting the central visual acuity. The first patient underwent the procedure for ERM (PVD already present before surgery) without intraoperative complications, and at the end of the procedure air tamponade was used. Twenty days postoperatively, she was diagnosed with macula-on RRD due to a new inferotemporal RB located just posterior to the previous laser treatment scar. The RRD was successfully managed with scleral buckling surgery. The final BCVA was 20/200. The second patient underwent vitrectomy for MH with intraoperative induction of PVD without intraoperative complications and at the end of the procedure received 11% C3F8 gas. Thirty-five days postoperatively, she was diagnosed with macula-on RRD, due to a new inferior RB located anterior to the previous laser treatment scar. The RRD remained demarcated by the peripheral laser and no additional treatment was necessary. The final BCVA was 20/60.

### Visual Acuity Outcomes and Macular Hole Closure Rate

A significant improvement in BCVA after PPV was shown. The mean preoperative BCVA was 20/127 and the mean postoperative BCVA was 20/48 ($P < 0.001$). A significant improvement in BCVA was also found in the ERM subgroup (mean preoperative BCVA 20/110 vs mean postoperative BCVA 20/41 [$P < 0.001$]) and in the MH subgroup (mean preoperative BCVA 20/139 vs mean postoperative BCVA 20/61 [$P < 0.001$]).

Six out of 110 patients with MH showed no MH closure (94.5% closure rate). Among these 6 patients, 2 did not comply with the recommended face-down positioning protocol. Among the patients who did show MH closure, all except 2 complied with the recommended face-down positioning. No MH reopening was observed.

## DISCUSSION

This study is a report of the impact of the prophylactic preoperative laser on rhegmatogenous retinal complications in macular surgery. To our knowledge, this laser timing has never been described in the literature.

In line with what seems to emerge both from comparative studies[3–5,8,11,13–15] (20-gauge vs 23/25-gauge) and from noncomparative studies[2,7,9,10,12] adopting no prophylactic measures, we found a greater risk of developing an intraoperative RB in 20-gauge PPV compared with 23/25-gauge PPV. In particular, the OR was even higher for sclerotomy-related RBs, whereas for nonsclerotomy-related RBs, and also for postoperative RRD,

**TABLE 2.** Comparison of Ocular and Patient Characteristics Between 20-Gauge and Small-gauge Pars Plana Vitrectomy Groups

| | | 20-G Vitrectomy | 23–25-G Vitrectomy | $P^*$ |
|---|---|---|---|---|
| Number of patients | Male | 47 (43.1%) | 65 (44.8%) | 0.79 |
| | Female | 62 (56.9%) | 80 (55.2%) | |
| | Total | 109 | 145 | |
| Age | 66.8 ± 6.5 | 68.4 ± 7 | 0.11 | |
| Diagnosis | Epiretinal membrane | 53 (48.6%) | 91 (62.8%) | **0.0297** |
| | Macular hole | 56 (51.4%) | 54 (37.2%) | |
| Lens status | Phakic | 82 (75.2%) | 117 (80.7%) | 0.35 |
| | Pseudophakic | 27 (24.8%) | 28 (19.3%) | |
| PVD induction | | 46 (42.2%) | 48 (33.1%) | 0.15 |
| Tamponade | Air | 49 (45%) | 91 (62.8%) | **0.005** |
| | $C_3F_8$ | 60 (55%) | 54 (37.2%) | |
| Retinal break | Sclerotomy-related | 9 (8.2%) | 1 (0.7%) | **0.0026** |
| | Nonsclerotomy-related | 2 (1.8%) | 2 (1.4%) | 1 |
| | Total | 11 (10%) | 3 (2.1%) | **0.0098** |
| Retinal detachment | | 2 (1.8%) | 0 (0%) | 0.18 |

PVD = posterior vitreous detachment.
*Bold values are significant.

there was no difference in risk. The higher number of ERMs among the entry diagnoses and the greater use of air tamponade in the small-gauge group might represent potential confounding factors (Table 2); however, since the number of PVD inductions did not differ significantly between small and 20-gauge PPV, this finding seems reliable.

In a review of the recent literature, we compared the incidence of intraoperative RBs and RRD in our 20-gauge and small-gauge PPV groups with those reported by other authors (Table 3).

Our incidence of intraoperative RB in the 20-gauge PPV group (10%) is higher than that reported in the study by Scartozzi et al,[8] but lower than that reported by all the other authors[3–4,7,12,14] (reported range 10.2%–24.3%), whereas that of our small-gauge PPV group (2.1%) is significantly lower than that of all the series reviewed[2–4,8,10,14,23] (reported range

**TABLE 3.** Percentage of Intraoperative Retinal Breaks and Postoperative Retinal Detachment Reported in the Recent Literature and in the Present Series

| | 20 G | | | 23/25 G | | |
|---|---|---|---|---|---|---|
| | RBs (%) | RRD (%) | RRD-L (%) | RBs (%) | RRD (%) | RRD-L (%) |
| Chung et al[12]; patient no. 311 | 10.2 | 0.9 | — | — | — | — |
| Tan et al[7]; patient no. 209 | 24.3 | 1.8 | — | — | — | — |
| Scartozzi et al[8]; patient no. 333 | 6.4 | — | — | 3.1 | — | — |
| Jalil et al[3]; patient no. 924 | 16.7 | 1.1 | — | 7.8 | 0.67 | — |
| Hikici et al[4]; patient no. 115 | 16 | 0 | — | 16 | 2 | — |
| Covert et al[14]; patient no. 415 | 23 | 5.9 | — | 3.3 | 2.8 | — |
| Rizzo et al[5,15]; patient no. 2432[5]/46[15] | — | 1.2 | — | — | 1.7 | — |
| Haas et al[13]; patient no. 231 | — | 1.8 | — | — | 1.6 | — |
| Koh et al[17]; patient no. 220* | — | 11.4 | 4.1 | — | — | — |
| Kim et al[21]; patient no. 278* | — | 5 | 1.2 | — | — | — |
| Chalam et al[18]; patient no. 144* | — | 8.82 | 1.31 | — | — | — |
| Iwase et al[20]; patient no. 112* | — | 5.7 | 0 | — | — | — |
| Tan et al[9]; patient no. 171 | — | — | — | 15.8 | 1.6 | — |
| Rahman et al[10]; patient no. 137 | — | — | — | 18.2 | — | — |
| Ehrlich et al[2]; patient no. 184 | — | — | — | 9.5 | 0.8 | — |
| Rasouli et al[16]; patient no. 268 | — | — | — | — | 1.1 | — |
| Parolini et al[22]; patient no. 900* | — | — | — | — | — | 0.2 |
| Tarantola et al[23]; patient no. 194* | — | — | — | 4.1 | — | 0 |
| Present series; patient no. 254† | 10 | — | 1.8 | 2.1 | — | 0 |

RBs = retinal breaks, RRD = rhegmatogenous retinal detachment, RRD-L = studies performing intraoperative* and preoperative† (present series) peripheral laser retinopexy.

3.1%–18.2%) (Table 3). As for postoperative RRD, we recorded an incidence of 1.8% in the 20-gauge group. This incidence is higher,[3–5,12,15] equal,[17,13] or lower[14,17,18,20,21] when compared with series without intraoperative PPLR (reported range 0%–11.4%), and higher[18,20,21] or lower[17] when compared with series with intraoperative PPLR (reported range 0%–4.1%). None of our patients in the small-gauge PPV group experienced postoperative RRD. This value compares favorably with that reported by authors who did not perform intraoperative PPLR[2–5,9,13–16] and is in line with that reported by the authors who did perform intraoperative PPLR[22,23] (Table 3).

The limitations of the present study worth mentioning are its retrospective nature, surgical procedures being performed by 2 surgeons, and the lack of a control group. Although without a control group we cannot assess the efficacy of preoperative prophylactic laser, some conclusions can nonetheless be drawn.

The fact that the rates of RBs and RRD in the present study are comparable with the corresponding rates in other case series that utilized intraoperative laser technique suggests no advantage of preoperative prophylactic laser over intraoperative laser treatment. Preoperative 360° PPLR might offer some possible advantages over 360° intraoperative PPLR, including no intraoperative breakdown of the blood-retinal barrier. For this reason we prefer preoperative rather than intraoperative prophylactic laser treatment; however, neither of the techniques guarantee the prevention of postoperative RRD, and new retinal breaks can develop at the margin of prior barrier laser scars, as happened in this study. Preoperative prophylactic laser showed no detrimental effect on the final BCVA outcome or MH closure rate. In fact, our visual acuity results and MH closure rate are in line with other studies on the subject.[14,20,26]

The choice to perform preoperative PPLR was made to create a postoperative barrier against the progression of RRD, which may rapidly involve the macula, if it occurs in vitrectomized eyes. Preoperative PPLR was performed 360° because postoperative RRD has been reported to be due to nonsclerotomy-related RBs in the majority of cases (as in the present series).[5,16,20] This goal was reached since in the present series, neither of the 2 patients with postoperative RRD was macula-off at presentation, one of them being successfully operated on with scleral buckling and the other one managed by observation alone.

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