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ORIGINAL PAPER

Pars plana vitrectomy with or without intraoperative 360° peripheral endolaser for rhegmatogenous retinal detachment treatment

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Abstract
Purpose The aim of this study was to investigate whether intraoperative 360° prophylactic endolaser photocoagulation is necessary for the treatment of uncomplicated retinal detachment.
Methods This prospective, randomized, comparative and interventional study includes 50 consecutive patients with primary rhegmatogenous retinal detachment (RRD) who were treated by pars plana vitrectomy. The patients were divided into two groups: in Group A endolaser applied to all existing breaks as well as a 360° laser retinopexy, while Group B received endolaser only to the retinal breaks. Primary anatomical success rate, a final best-corrected visual acuity (BCVA) and postoperative complications were analyzed and compared between the groups at 1 and 3 months.
Results After the primary procedure, the retina was reattached in 96% (24 of 25) of patients in Group A and in 88% (22 of 25) of patients in Group B at 1 and 3 months. The mean final BCVA (logarithm of the minimum angle of resolution) improved from 1.26 to 0.52 in Group A with 17 cases (68%) macula-off and 1.19 to 0.77 in Group B with 18 cases (72%) macula-off at preoperative and final follow-up visit. Epiretinal membranes were seen in four cases in Group A and four cases in Group B at 3 months. No statistically significant difference in the anatomical, functional and complication outcomes between the two groups was recorded.
Conclusions Pars plana vitrectomy without the 360° peripheral endolaser can provide successful anatomic outcomes and functional improvement in uncomplicated primary RRDs.

Keywords 360° Endolaser · Peripheral endolaser · Primary rhegmatogenous · Retinal detachment · Vitrectomy

Introduction

Rhegmatogenous retinal detachment (RRD) is characterized by the presence of a full-thickness retinal break. This break is held open by vitreoretinal traction that allows accumulation of liquefied vitreous under the retina separating it from the RPE [1]. Once the retina is detached, surgical procedures are required to reattach it and seal the breaks. The most commonly used treatment modalities for the management of RRD include scleral buckling (SB), pars plana vitrectomy (PPV), pneumatic retinopexy, and combination techniques [2]. The main goals of surgical management of

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RRD are to detect all retinal breaks, sealing the retinal breaks by creating a chorioretinal scar around the breaks (retinopexy), drainage of subretinal fluid in some cases, and relief of vitreoretinal traction [3].

Pars plana vitrectomy is growing in popularity as a first-line procedure for RRD. The better intraoperative control of PPV is supported by the high rates of intraoperative reattachment, even in very difficult cases, achieved by internal drainage and endotamponade [4]. It has several advantages over SB, and the major benefit of PPV is the potential for an improved view of the retinal periphery, allowing increased identification of retinal breaks [5]. Pars plana vitrectomy allows for more controlled drainage of subretinal fluid, either with perfluorocarbon liquids or internal drainage techniques. This may achieve complete intraoperative retinal attachment without the risk of hemorrhage or retinal incarceration inherent in external drainage procedures [6]. Pars plana vitrectomy is unlikely to cause significant motility disturbances, is frequently less painful, and is less likely to cause significant refractive changes than SB. Disadvantages and complications may also occur with PPV for primary retinal detachment. In addition, PPV is associated with increased risk of new retinal breaks, cataract formation, and intraocular pressure elevation [5].

Previous studies have shown that the major causes of retinal redetachment are missed breaks, opening of old breaks due to persistent or renewed traction or new break formation [7]. Different additional procedures in vitrectomy are applied to reduce the risk of peripheral retinal breaks and retinal redetachments, including scleral buckling or 360° prophylactic endolaser photocoagulation. However, some authors have advocated that the addition of a buckle does not improve anatomic success rates and is associated with higher complication rates such as macular pucker, glaucoma, motility disturbances, and refractive changes. [8, 9] Theoretically, application of 360° peripheral laser may serve to reduce the rate of redetachment by walling off any detachment that might occur anterior to the barrage and may be treated any missed breaks. This can be easily performed during the vitrectomy procedure with the endolaser probe or indirect laser delivery system [10].

In the present study, we aimed to investigate whether intraoperative 360° prophylactic endolaser photocoagulation is necessary for the treatment of uncomplicated retinal detachment.

Methods

This prospective, controlled study included 50 consecutive patients who underwent PPV for primary RRD by a single surgeon (ABB). The study protocol was approved by the Akdeniz University Clinical Research Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki. A written informed consent was obtained from each patient.

Fifty eyes of 50 patients who underwent transconjunctival PPV with a 23-G system between June 2014 and January 2015 were registered. The patients were assigned consecutively into two groups: Group A (n = 25) who underwent PPV with 360° peripheral endolaser and Group B (n = 25) who underwent PPV without 360° peripheral endolaser. Surgeries were performed under local anesthesia at Akdeniz University Hospital, Department of Ophthalmology.

Exclusion criteria were as follows: pediatric patients, proliferative vitreoretinopathy (PVR) Grade C or worse, giant tear, retinal dialysis, eye trauma and traumatic RRD, proliferative diabetic retinopathy, stiffness of the retina and the need for retinectomy, and a follow-up less than 3 months.

The patients included were assigned consecutively to be treated with primary PPV with or without a prophylactic intraoperative 360° endolaser. Randomization was determined by patient order.

Data including age, sex, ocular history, duration of symptoms, lens status, location of the retinal breaks, extent of retinal detachment, macula status, grade of proliferative vitreoretinopathy (PVR), tamponade agent, final best-corrected visual acuity (BCVA), final anatomic status of retina, and epiretinal membrane and macular hole development status were recorded. The BCVA was measured on an Early Treatment Diabetic Retinopathy Study chart and converted to log Mar. Anterior and posterior slit-lamp evaluation was performed, with special care taken to identify all retinal breaks and to describe the location and extension of the RD and any presence of PVR. The patients were seen at 1 day, 1 week, 1 month, and 3 months after surgery. The same ophthalmologic examination was repeated at each visit. If the visual acuity did not

improve as expected, an optical coherence examination of the macula was performed to detect epiretinal membranes, macular holes, any persistent subretinal fluid, or other complications.

All patients underwent three-port PPV using the 23-G with a single-step trocar/cannula assembly (Constellation® Vision System, Alcon Laboratories Inc., Fort Worth, TX, USA). In both groups, after core vitrectomy was performed, the surgeon confirmed that the posterior vitreous was detached. The vitreous base was thoroughly shaved using 360° scleral depression. Reattachment of the retina under perfluoro-N-octane (PFO) was performed in all cases. Subretinal fluid was removed through the existing retinal tears, and if the tears or holes were not large enough to allow complete drainage, they were expanded with the vitreous cutter and endocauthery applied around it. All retinal tears were treated with three to four rows of endolaser photocoagulation under perfluorocarbon. For the Group A, three rows of medium-white burns were positioned anterior to the equator. The intraocular tamponade, C3F8 gas, SF6 gas, or 1000 cSt silicone oil, was chosen by the surgeon. Indications for using silicone oil instead of gas were the need for air traveling, inability to lie face down, and longer duration of RRD. Criteria for silicone oil removal, usually planned three to 6 months after primary RD surgery, were retinal reattachment during follow-up examinations. Although most of sclerotomies were sealed by massage, incisions were sealed by a single stitch with 7-0 Vicryl sutures, if obvious leakage was observed. All surgeries were finalized with subconjunctival injection of dexamethasone and gentamicin. The patients with C3F8 gas tamponade were requested to maintain face-down positioning for 1 week postoperatively independent of the location of the break.

Statistical analysis

Statistical analysis was performed using the SPSS version 18.0 software (SPSS Inc., Chicago, IL, USA). The Fisher's exact test, *t* test, and Pearson Chi-square test were used for comparisons between the groups. A *P* value of less than 0.05 was considered statistically significant.

Results

Patient characteristics

Fifty patients operated on for primary RRD who met the inclusion criteria were enrolled in this study. The patients were randomly assigned into two groups with or without 360° endolaser treatment. Table 1 shows the baseline demographic and clinical data of all patients included age, sex, duration of symptoms, and lens status. There was no statistically significant difference in the baseline demographic and clinical characteristics between the two groups.

In 17 eyes (68%), the macula was detached, and the mean number of retinal breaks was 2.96 and superior localization of retinal breaks was 14 (56%) in Group A at the time of diagnosis. In 18 eyes (72%), the macula was detached, and the mean number of retinal breaks was 2.52 and superior localization of retinal breaks was 10 (40%) in Group B at the time of diagnosis. Table 2 shows the initial retinal detachment characteristics: number of retinal breaks, retinal breaks localization, extent of the RRD, macular status, and grade of proliferative vitreoretinopathy. There was no statistically significant difference in the initial retinal detachment characteristics between the two groups. Figure 1 shows the tamponade agents used (C3F8 gas, SF6 gas or 1000 cSt silicone oil). There was no statistically significant difference between the two groups in terms of the tamponade agents used.

Anatomical outcomes

Table 3 shows single-surgery anatomic success (SSAS) rate and development of epiretinal membrane or macular hole. The first-month and third-month postoperative SSAS rate in Group A was 96% (retinal redetachment developed in one patient), in Group B was 88% (retinal redetachment developed in three patients). Although we evaluated the first and third months as statistical analysis, we looked at the next follow-ups of patients who underwent silicone extrusion and only one patient in Group B developed retinal redetachment 4 months after silicon extrusion. None of the patients developed retinal redetachment in Group A after silicon extrusion. The anatomical success rate was 100% after one or more reoperations in all patients in both groups. There was no statistically

Table 1 Demographic and baseline clinical characteristics

	Total	Group A	Group B	*P* value
Age				0.62
Years (mean)	59.62 ± 8.9 (38–86)	60.24 ± 8.3 (48–80)	59 ± 9.6 (38–86)	
Sex				0.75
Male *n* (%)	35 (70%)	17 (68%)	18 (72%)	
Female *n* (%)	15 (30%)	8 (32%)	7 (28%)	
Eye				0.39
Right *n* (%)	25 (50%)	11 (44%)	14 (56%)	
Left *n* (%)	25 (50%)	14 (56%)	11 (44%)	
Duration of symptoms				0.71
Days (mean)	17.96 ± 19.8 (2–90)	16.16 ± 18.4 (3–90)	19.76 ± 21.2 (2–90)	
Lens status				0.25
Phakic *n* (%)	22 (44%)	13 (52%)	9 (36%)	
Pseudophakic *n* (%)	26 (52%)	11 (44%)	15 (60%)	
Aphakic *n* (%)	2 (4%)	1 (4%)	1 (4%)	

Table 2 The initial retinal detachment characteristics

	Total	Group A	Group B	*P* value
Number of retinal breaks				0.67
n (mean)	2.74	2.96	2.52	
Localization of retinal breaks				0.46
Superior *n* (%)	24 (48%)	14 (56%)	10 (40%)	
Inferior *n* (%)	11 (22%)	4 (16%)	7 (28%)	
Superior + inferior *n* (%)	15 (30%)	7 (28%)	8 (32%)	
Extent of The RD				0.63
n of Quadrants (mean)	6.94	6.68	7.20	
Macula status				0.75
Attached *n* (%)	15 (30%)	8 (32%)	7 (28%)	
Detached *n* (%)	35(70%)	17 (68%)	18 (72%)	
PVR				0.30
No PVR *n* (%)	38 (76%)	19 (76%)	19 (76%)	
PVR A *n* (%)	10 (20%)	4 (16%)	6 (24%)	
PVR B *n* (%)	2 (4%)	2 (8%)	0 (0%)	

PVR proliferative vitreoretinopathy

significant difference in the SSAS rates at 1 and 3 months between the two groups ($P = 0.29$).

Functional outcomes

In 70% of the macula-off eyes, the mean final BCVA was log MAR 0.64 (Snellen 20/87). In both groups, the mean BCVA was found to be significantly improved at the first week, first month, third month, and final follow-up visits. In Group A, the mean BCVA was log MAR 1.26 (Snellen 20/363), 1.64 (Snellen 20/873), 1.06 (Snellen 20/230), 0.66 (Snellen 20/91), and log MAR 0.52 (Snellen 20/66) at preoperative, first week, first month, third month, and final follow-up visits, respectively. In Group B, the mean BCVA was log MAR 1.19 (Snellen 20/309), 1.58 (Snellen 20/760), 1.19(Snellen 20/316), 0.85 (Snellen 20/141), and log MAR 0.77 (Snellen 20/117) at preoperative, first

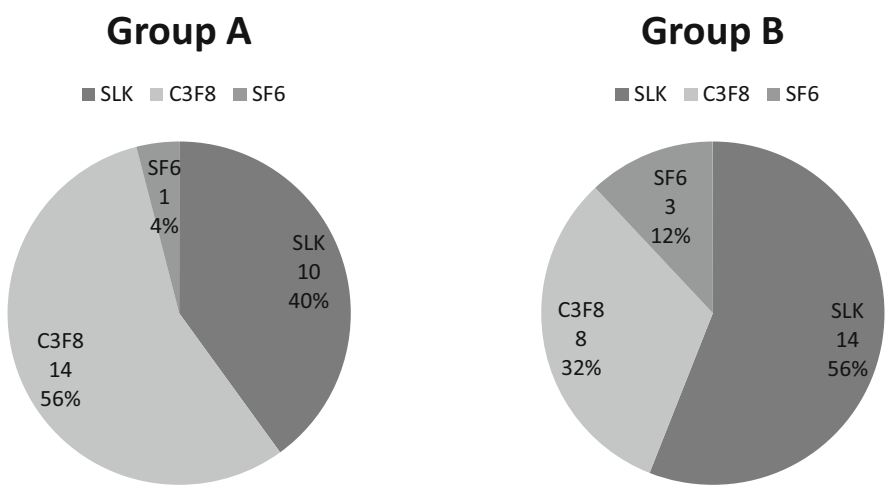

Fig. 1 Tamponade agents ($P = 0.192$)

Table 3 SSAS rate, mean BCVA and complications

	Total		Group A		Group B		*P* value	
	Month 1	Month 3	Month 1	Month 3	Month 1	Month 3	Month 1	Month 3
SSAS							0.29	0.29
Retinal attachment *n* (%)	46 (92%)	46 (92%)	24 (96%)	24 (96%)	21 (88%)	21 (88%)		
Retinal redetachment *n* (%)	4 (8%)	4 (8%)	1 (4%)	1 (4%)	3 (12%)	3 (12%)		
BCVA							0.30	0.22
Log MAR (mean)	1.12	0.75	1.06	0.66	1.19	0.85		
Complicat.							0.39	0.74
ERM *n* (%)	6 (12%)	8 (16%)	3 (12%)	4 (16%)	3 (12%)	4 (16%)		
MH *n* (%)	2 (4%)	2 (4%)	2 (8%)	2 (8%)	0 (0%)	0 (0%)		

SSAS single-surgery anatomic success, *BCVA* best-corrected visual acuity, *log MAR* logarithm of the minimum angle of resolution, *Complicat.* complications, *ERM* epiretinal membrane, *MH* macular hole

week, first month, third month, and final follow-up visits, respectively. There was no statistically significant difference in the mean BCVA at 1 and 3 months between the groups ($P = 0.30$), ($P = 0.22$).

Complications

In the first month, epiretinal membrane developed in three patients in both groups. Macular hole developed in two patients in Group A, while in Group B, macular hole was not seen as a complication. In the third month, epiretinal membrane was present in four patients in each group. There was no change in macular hole formation after 1 month. There was no statistically significant difference in the development of ERM ($P = 0.99$, $P = 0.99$) or macular hole ($P = 0.49$, $P = 0.49$) at 1 and 3 months.

Discussion

Reattachment of the retina and prevent redetachment of the retina is necessary in surgery for RRD to provide anatomical and functional improvement. Peripheral retinal breaks after vitrectomy usually occur along the posterior margin of the vitreous base and are most common in the meridians of the pars plana sclerotomies. These breaks are thought to be caused by traction on the vitreous base [11]. As a result, these breaks may cause redetachment. Additional

procedures in vitrectomy are applied to reduce the risk of peripheral retinal breaks and retinal redetachments including scleral buckling or 360° prophylactic endolaser photocoagulation. The aim of this study was to demonstrate whether 360° prophylactic endolaser photocoagulation is needed for the uncomplicated RRD.

Some authors advocate that combined vitrectomy and scleral buckle treatment demonstrates a higher failure rate than vitrectomy alone in uncomplicated retinal detachments. The addition of a buckle was not found to improve anatomic success rates, but was associated with higher complication rates, including macular pucker, macular edema, and glaucoma [8, 9, 12].

There are several reports about the use of 360° prophylactic endolaser photocoagulation as an additional procedure during PPV to reduce the retinal detachment rate; however, many of these articles are about the vitrectomy treatment of macular diseases and not RRD [10, 13, 14]. The rest of are about the 360° laser reduces the retinal detachment rate before silicon oil removal [15–17]. However, there are not many publications about the benefits of applying 360° prophylactic endolaser photocoagulation in PPV for RRD.

According to the comparison of demographics, clinical data, and initial retinal detachment characteristics, both groups were well-balanced and there were no significant differences between the two groups. The age, sex, duration of symptoms, lens status, number of retinal breaks, retinal breaks localization, extent of the RRD, macular status, and grade of proliferative vitreoretinopathy and tamponade were similar between two groups.

This prospective, controlled study included 50 consecutive patients who underwent PPV for primary RRD. The SSAS rate at 1 and 3 months in Group A was 96% (retinal redetachment developed in one patient), in Group B was 88% (retinal redetachment developed in three patients). Overall, the SSAS rate was 92%. The SSAS rate varies in the literature, ranging from 77 to 96.2% for primary RRD treatment with PPV [16, 18–20]. Schneider et al. [21] reported a SSAS rate of 95% and suggested that PPV alone, without adjuvant scleral buckling, 360° endolaser photocoagulation, or routine perfluorocarbon liquid use, yielding high anatomical and functional success rates and low complication rates in the treatment of primary uncomplicated RRD. In another study, Koh et al. [10] found that the application of 360° endolaser reduced the incidence of retinal detachment from 13.3% (14/105 eyes) to 3.5% (4/115 eyes) in patients with vitreal or macular diseases excluding retinal detachment. Yang et al. [14] found that the rate decreased from 2.6 to 0% in patients with macular diseases (ERM or MH) who underwent PPV. The authors concluded that 360° endolaser reduced the incidence of retinal detachment after PPV. In addition, Iwase et al. [13] evaluated the effect of using 360° laser on the incidence of retinal detachment for MH and RRD treatment with PPV. They found that the 360° laser group of MH showed a significant reduction (0%, 0/77 eyes) compared to the control group (5.7%, 2/35 eyes) ($P = 0.034$). However, there was no significant difference between the groups in RRD cases, while the 360° laser group of RRD showed 1.9% (2/108 eyes) retinal detachment, and the control group had 5.9% (16/270 eyes) ($P = 0.092$). The other reports about the 360° laser reduces the retinal detachment rate before silicon oil removal are Laidlaw et al. [15] (the rate decreased from 26 to 14%), Zhou et al. [16] (the rate decreased from 41.1 to 7.7%) and Tufail et al. [17] (the rate decreased from 25 to 6.7%). These authors concluded that prophylactic laser retinopexy applied before silicon oil removal might reduce the incidence of retinal redetachment after removal of silicone oil.

Similar to our study, Barrada et al. [22] divided 80 patients with primary RRD into two groups, and the SSAS rate was 75% of the patients who received 360° laser versus 67.5% of those who did not ($P = 0.32$). The results in both groups were consistent, but these results are lower than our data. They had macula-on detachments in only 3.6%, PVR in 91%, including 35% with PVR Grade C, and the mean duration of the detachments was 54.3 ± 80.7 days in their study group. The authors concluded that prophylactic intraoperative 360° laser retinopexy did not have a role in the prevention of retinal redetachment after primary retinal repair with 23-G transconjunctival vitrectomy and the only adverse effect associated with 360° laser retinopexy was postoperative anisocoria. In our study, macula-on detachments were present in 30% and PVR in 24% of the patients. We excluded patients with PVR Grade C and the mean duration of the detachments in our study was 17.9 days. The results of SSAS in both groups were consistent and statistical analyses showed

no statistically significant difference between the two groups in SSAS rate at 1 and 3 months. Our patients consisted of fresh and uncomplicated RRD, unlike Barrada et al. [22] study. We believe that the similarity of the results about prophylactic 360° photocoagulation suggests that the procedure is of no significant value in either long-standing, complicated or fresh and uncomplicated cases of RRD.

In our study, overall eyes achieved a mean final BCVA of log MAR 0.64 (Snellen 20/87) which was similar between both treatment groups. However, there was a tendency toward improved final BCVA outcomes in the Group A at 3 months [log MAR 0.66 (Snellen 20/91) versus log MAR 0.85 (Snellen 20/141)] ($P = 0.22$), and at the final follow-up visits [log MAR 0.52 (Snellen 20/66) versus log MAR 0.77 (Snellen 20/117)] ($P = 0.17$). Falkner et al. [19] reported that, in 65% of macula-off RRD, the mean final BCVA was log MAR 0.39, while Romano et al. [18] reported that, in 68% of macula-off RRD, the mean final BCVA was log MAR 0.43 and Schneıder et al. [21] showed that, in 52% of macula-off RRD, the mean final BCVA was log MAR 0.29. We concluded that our functional outcomes were lower than previous findings, as the number of patients with macular-off RRD was high.

Furthermore, postoperative complications during the study included eight (16%) cases of epiretinal membrane (ERM), four in Group A, and four in Group B. Macular hole developed in two patients (8%) in the Group A. In a study including 91 patients, Ryan et al. [23] reported that 3.2% (3/91) developed ERM ($n = 2$) and MH ($n = 1$) and these patients underwent a second PPV for repair. The authors suggested that the development of ERM was a disadvantage of PPV, compared to scleral buckling. In another study by Katira et al. [24], 18 of 141 patients (12.8%) developed postoperative ERM and underwent primary RD repair with PPV alone. The authors concluded that vitrectomy repair was associated with a higher rate of macular pucker formation, compared to scleral buckling, arising from the assumption that the retinal pigment epithelium and other progenitor cells are dispersed more freely and in greater number after vitreous removal and suctioning of subretinal fluid through a peripheral break or a posterior retinotomy. Another study by Chaturvedi et al. [25] evaluated 91 patients who underwent primary RRD repair with PPV. They reported that the rate of ERM formation was 3.2% and they thought that the 360° peripheral endolaser with PPV might promote the formation of ERM postoperatively. Unlike previous studies, our results were higher. The main reason for this is that previous studies reported only ERM rates requiring PPV, while we reported all ERM rates. In our study, only one patient in each group required surgery for ERM. Crafoord et al. [26] indicated that broad application of photocoagulation aggravated experimental PVR, as laser photocoagulation induces the invasion of macrophages, proliferation of retinal pigment epithelium, and a conspicuous Müller cell response. All these factors may enhance intraocular inflammation and stimulate intravitreal proliferation and consequently aggravate PVR. In our study, ERM formation occurred equally in both groups. Since our sample size is small, further, large-scale studies are needed to validate the effect of 360° peripheral endolaser photocoagulation on aggravation of ERM or PVR.

In conclusion, PPV without the 360° peripheral endolaser can provide successful anatomic outcomes and functional improvement in phakic, pseudophakic, inferior, superior, macula-on, and macula-off uncomplicated primary RRDs. We recommend that a randomized, prospective, large-scale clinical trial is necessary to definitively determine the efficacy, complications such as ERM or PVR and the best indication for 360° peripheral endolaser.

Compliance with ethical standards

Conflict of interest The authors declares no conflict of interest and no relevant financial relationships to disclose.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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