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The results of vitrectomy in patients with rhegmatogenous retinal detachment

Rezultati vitrektomije pri bolnikih z regmatogenim odstopom mrežnice

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Abstract

Background: We evaluated the anatomical and functional results of pars plana vitrectomy (PPV) for the treatment of complex rhegmatogenous retinal detachment (RRD).

Methods: A retrospective analysis was performed on 88 eyes of 88 patients with complex RRD managed by PPV. We determined the anatomical success rate as well as functional outcomes based on best-corrected visual acuity (BCVA) in the whole cohort of patients and in the groups classified based on crystalline lens status, macular status, and the presence of proliferative vitreoretinopathy (PVR) grade ≥ C1. An optical coherence tomography (OCT) macular imaging was used to obtain images at the postoperative visit at least six months after PPV and determine the presence of discontinuity of ellipsoid zone (EZ), cystoid macular oedema (CME), epiretinal membrane (ERM), or macular hole (MH).

Results: Anatomical outcome of primary PPV was 93.2%. Final retinal reattachment was achieved in all patients (88 eyes, 100%). BCVA improved from preoperative BCVA 1,7 ± 1,2 SD logMAR to postoperative BCVA 0,6 ± 0,7 SD logMAR (p=0,01). We showed worse anatomical outcomes in the group of patients with PVR grade ≥ C1 (89.7%). Postoperative BCVA improved in all groups of patients, but after analysis according to the groups statistically significantly only in the phakic group (p=0.019), macula-off group (p=0.016), and in the group of patients with the presence of PVR grade ≥ C1. Final BCVA was better in the pseudophakic group (0.75 ± 1.06), in the macula-on group (0.78 ± 1.30) and in patients without the presence of PVR (0.80 ± 1.15 logMAR). Postoperative OCT macular analysis showed discontinuity of EZ in 39%, CME in 15%, ERM in 2% and MH in 2%. Comparison of OCT variables according to the groups based on lens status, macular status, and presence of PVR grade ≥ C1 showed the largest proportion of discontinuity of EZ in the group of patients with presence of PVR grade ≥ C1 (58.6%).

Conclusion: The anatomical and functional results of PPV in the treatment of complex RRD were highly successful. The overall functional outcome was better in pseudophakic patients, patients with macula-on detachment and patients

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Key words: retinal detachment; pars plana vitrectomy; visual acuity; proliferative vitreoretinopathy; discontinuity of ellipsoid zone

Ključne besede: odstop mrežnice; vitrektomija pars plana; vidna ostrina; proliferativna vitreoretinopatija; prekinitev elipsoidnega sloja

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without PVR. The largest proportion of patients with discontinuity of the EZ was in the group of patients with preoperative PVR.

Izvleček

Izhodišča: Ovrednotili smo anatomski in funkcionalni izid zdravljenja kompleksnega regmatogenega odstopa mrežnice z vitrektomijo pars plana (PPV).

Metode: V retrospektivno raziskavo smo vključili 88 oči 88 bolnikov, ki so bili zaradi kompleksnega regmatogenega odstopa mrežnice zdravljeni s PPV. Določili smo anatomski uspeh in funkcionalni izid na podlagi korigirane vidne ostrine (VO) v celotni skupini bolnikov in v skupinah glede na status očesne leče, rumene pege in prisotnosti proliferativne vitreoretinopatije (PVR) stopnje ≥ C1. Z optično koherenčno tomografijo (OCT) rumene pege smo vsaj 6 mesecev po PPV ovrednotili prisotnost prekinitev elipsoidne cone, cistoidnega makularnega edema (CME), epiretinalne membrane (ERM) ali makularne luknje.

Rezultati: Anatomski uspeh je bil po primarni PPV 93,2 %. Končni anatomski uspeh je bil dosežen pri vseh 88 bolnikih (100 %). Korigirana VO se je statistično značilno izboljšala iz VO 1,7 ± 1,2 SD logMAR pred operacijo na VO 0,6 ± 0,7 SD logMAR po operaciji (p=0,01). Med skupinama bolnikov je glede na prisotnost PVR izstopal slabši anatomski izid v skupini s PVR stopnje ≥ C1 (89,7 %). Korigirana VO se je po operaciji izboljšala pri vseh skupinah bolnikov, vendar po analizi glede na skupine statistično značilno le v skupini fakih (p=0,019), z odstopom rumene pege, (p=0,016) in s prisotnim PVR stopnje ≥ C1 (p=0,028). Končna VO je bila boljša v skupini psevdofakih (0,75 ± 1,06), v skupini bolnikov z ležečo rumeno pego (0,78 ± 1,30) in pri bolnikih brez PVR (0,80 ± 1,15 logMAR). Analiza OCT rumene pege po operaciji je pokazala prisotnost prekinitev elipsoidne cone v 39 %, CME v 15 %, ERM v 2 % in makularne luknje v 2 %. Primerjava spremenljivk OCT glede na skupine na podlagi statusa očesne leče, rumene pege in prisotnosti PVR stopnje ≥ C1 je pokazala največji delež prekinitev elipsoidne cone v skupini oči s prisotnim PVR stopnje ≥ C1 (58,6 %).

Zaključek: Ugotovili smo visoko stopnjo anatomske in funkcionalne uspešnosti zdravljenja kompleksnega regmatogenega odstopa mrežnice z vitrektomijo. Funkcionalni izid je bil boljši pri bolnikih z umetno znotrajočesno lečo, pri bolnikih z ležečo rumeno pego in pri bolnikih brez PVR. Največji delež bolnikov s prekinjeno elipsoidno cono je bil v skupini bolnikov s predoperativno PVR.

1 Introduction

Rhegmatogenous retinal detachment (RRD) is defined as the separation of the neurosensory retina from a retinal pigment epithelium due to an accumulation of fluid under the retina caused by a tear or a hole. It is a potentially vision-threatening retinal disorder that, without proper treatment, leads to irreversible loss of vision (1). The incidence of RRD in Europe according to a systematic review of literature and a meta-analysis is 9.5–18.2 per 100,000 per year (2).

Therapeutic options are surgical only. The main principle of a surgical procedure is the release of a vitreoretinal traction and closure of a retinal tear(s). Standard surgical treatment options for RRD are pneumatic retinopexy, scleral buckling, and pars plana vitrectomy (PPV). The appropriate surgical approach is mainly chosen according to the complexity of detachment, age of the patient, and surgeon's preference (3). In simple RRD, detachment is localized to a single, small retinal tear or hole at the retinal periphery accompanied by good visibility of the fundus (3). The methods of choice for simple RRD are pneumatic retinopexy and scleral buckling surgery (4). Complex RRD is partial, subtotal, or total detachment with multiple retinal breaks, posterior breaks, retinal dialysis, or giant tears (4). It can be associated with vitreous haemorrhage, ocular trauma, and proliferative vitreoretinopathy (PVR) (3). The surgical method of choice for complex RRD is PPV (4) with a relatively high rate of successful anatomical outcome. For primary PPV, primary anatomical success rate ranged from 70 to 94% (4-7) and final anatomical success rate ranged up to 100% (3,4,7,8).

Postoperative PVR is the most common cause for unsuccessful anatomical outcome after PPV for RRD with an incidence of 5.1–11.7% (9,10). The high rate of anatomical outcome of PPV for the treatment of RRD does not guarantee comparable functional outcome. Functional outcome is variable and associated with various preoperative factors. To date, numerous studies have associated worse functional outcome of PPV with preoperative factors such as worse preoperative best-corrected visual acuity (BCVA) (6,7), longer duration of symptoms (6,7), macula-off detachments

(6,11-14), and presence of PVR (4,6,15,16). Diversity of functional outcome after surgical treatment for RRD, despite good anatomical outcome, can be explained by a postoperative structural analysis of retinal layers of macula, which is enabled by optical coherence tomography (OCT) macular imaging. Several studies have shown an association between functional outcome after surgical treatment and morphological changes of the macula (17-21).

The purpose of our retrospective analysis was to evaluate the anatomical and functional outcomes of the treatment of RRD with PPV and to determine the results according to crystalline lens status, formerly performed cataract surgery (phakic/pseudophakic), preoperative macular status (on/off), and presence of preoperative PVR. In these groups of patients, we determined postoperative morphological changes on OCT that affects BCVA.

2 Methods

2.1 Patient selection

This study used retrospective data collection of patients treated primarily by PPV for complex retinal detachment between January and December, 2016 at the Eye Hospital, University Medical Centre Ljubljana, Ljubljana, Slovenia. The study was conducted in accordance with the tenets of the Declaration of Helsinki. Written informed consent from all patients was obtained for surgical procedure.

Eighty-eight patients who underwent PPV for RRD were included in the study. The exclusion criteria were: patients treated by scleral buckle, pneumatic retinopexy, combined PPV and scleral buckle, retinal cryopexy during PPV, retinal detachment related to previous eyeball trauma, and patients with other retinal pathology potentially affecting macular morphology and visual function. All patients had at least one follow-up appointment at the Eye Hospital, and they completed both visual acuity assessments and OCT imaging of the macula. All surgeries were performed by one experienced retinal surgeon (XL).

2.2 Data collection

The data collected from patient's records retrospectively was: age at the time of surgery, gender, axial length (AL) of the operated eye, duration of symptoms, best corrected visual acuity (BCVA), presence of crystalline lens or intraocular lens (IOL), preoperative macular status (on/off), and presence of PVR grade ≥ C1. PVR stage was graded according to the updated classification of Retina Society Terminology Committee (1991) (22).

Macular status was determined by indirect biomicroscopy upon admission of the patient. B-scan ocular ultrasound was performed in retinal detachments with opaque optical media. In retinal detachments with clear optic media and macula-on, AL measurement was provided by IOL Master Optical Biometer (Carl Zeiss Meditec AG, Jena, Germany). In retinal detachments with opaque optical media or macula-off, the AL was determined by A-scan ultrasound biometry using 10 MHz frequency probe. The choice of endotamponade (air, type of gas or silicon oil) was recorded.

A Topcon swept source optical coherence tomography (SS OCT, DRI OCT Triton, Topcon, Tokyo, Japan) with horizontal cross-sectional B scan image was used to obtain all OCT macular imaging at least six months after the surgical procedure. Central retinal thickness (CRT) was measured using a software-based measurement tool, that calculated retinal thickness automatically on the nine ETDRS subfields. The OCT macular image was analyzed and the following data was recorded: presence of epiretinal membrane (ERM), macular hole (MH), ellipsoid zone (EZ) discontinuity, and cystoid macular edema (CME). Patients were diagnosed with CME if the central macular thickness (central 1000 μm wide region) was ≥300 μm on SS-OCT imaging (23), or intraretinal oedema or fluid was detected on OCT (24). ERM was diagnosed based on the consensus of OCT definition of ERM by Hubschman et al. (25).

Anatomical success of the surgical procedure was achieved when the retina was fully seated (centrally and in all four quadrants up to the ora serrata) after six months of follow-up after primary PPV and gas tamponade, or six months after SO removal in eyes after PPV and SO endotamponade. BCVA was defined as improved when the patient was able to read at least one line of optotypes more on Snellen chart at the follow-up appointment six months after the last surgical procedure compared to the preoperative condition. At the same postoperative visit, functional outcomes were recorded by determining BCVA in Snellen decimal units, which were further transformed to logMAR units. The need for additional secondary surgical intervention and a second surgery due to retinal re-detachment were also recorded.

2.3 Surgical procedure

The surgical procedure was performed under either regional or general anesthesia. A 3-port PPV was

performed in all patients, using 23- or 25-gauge instrumentation occasionally in combination with a 29-gauge chandelier endoillumination. Trocars were placed in a way that allows a peripheral vitrectomy to be performed without touching the crystalline lens and switching between the three entry sites if necessary. Endolaser photocoagulation using a curved probe was applied around the retinal tears or 360° to retinal periphery in patients where retinal tears were in all four quadrants or in patients with a giant retinal tear. At the end of the surgery, air-gas mixture (either 20% sulphur hexafluoride-SF6 or 10-15% perfluoropropane-C3F8) or silicon oil (SO, 2000 Centistokes) endotamponade were used. SO was used in patients with RRD in the only functional eye, in patients with peripheral retinectomies (that included two or more quadrants or with giant tears), and in those who were unable to maintain a facedown posture after the surgical procedure. The removal of SO was performed three months after PPV. When the air or gas mixture was used as endotamponade, patients were asked to maintain a facedown posture for a week.

If visualization of the retina was not sufficient because of a lens opacity, a combined surgical procedure with cataract surgery (phacoemulsification and IOL implantation in capsular bag) and a vitrectomy was performed. The combined surgical procedure was necessary in eight patients. Cataract surgery was performed in five patients during the follow-up period or at the time of SO removal three months after primary PPV.

2.4 Statistical analysis

The frequencies for categorical variables, means with standard deviations (SD), and ranges for numerical variables were calculated. In the first step, anatomical and functional outcome of the whole cohort of patients were calculated. Functional outcome was determined based on preoperative and postoperative BCVA, converted to logMAR units. In the second step, patients were divided into two groups based on crystalline lens status (group of patients with crystalline ocular lens – phakic, and group of patients with artificial intraocular lens – pseudophakic; the last group included patients after cataract surgery without intraocular lens – aphakic), macular status (on/off), and presence of PVR. Anatomical and functional outcome were calculated for each group of patients. The results within each group of patients were compared with the paired t-test. The significance level was set at $p<0.05$ for all statistical tests.

3 Results

3.1 Demographic data

A total of 88 eyes of 88 patients after primary PPV for complex RRD were enrolled in the study. The mean age of all patients at the time of the surgical procedure was 59.9 years ± 1.4 SD (range: 18–85 years). The sex ratio was characterized by male predominance (60 males, 28 females, ratio 2:1). The mean age of the males, 59.8 years ± 12.5 SD (range 18–84 years), and females, 60.4 years ± 12.4 SD (range: 25–85 years), did not differ significantly. Duration of symptoms of retinal detachment was on average 28 days ± 70.2 SD with a range of 0 to 550 days. Fifty-three patients had their own crystalline lens (60.2%), thirty-two (36.4%) had IOL, and only two did not have intraocular lens (aphakic). More than two thirds of patients had RRD with macula-off (68 patients, 77%). A third of the patients (29 patients, 33%)

Table 1: Demographic and ocular characteristics of patients enrolled in the study.

Variable	Patients (n=88)
Age (mean ± SD; range)	59.9 years ± 1.4 SD; range: 18–85 years
Male/female (n; %)	60 (68%) / 28 (32%)
Duration of symptoms (mean ± SD; range)	27.9 ± 70.2 days; range 0–550 days
Axial length of the operated eye	24.7 mm ± 2.0 SD; range: 21.2–32.4
Crystalline lens status (n, %) • phakic • aphakic • pseudophakic	 53 (60,2%) 3 (3,4%) 32 (36,4%)
Macular status (n, %) • macula-on • macula-off	 20 (23%) 68 (77%)
Presence of PVR (n, %) • no PVR • PVR grade ≥ C1	 59 (67%) 29 (33%)
Endotamponade during the surgery • 20% SF_6 • 15% C_3F_8 • 10% C_3F_8 • air • SO	 13 (15%) 25 (28%) 30 (34%) 2 (2%) 18 (21%)

Legend: n – number; SD – standard deviation; PVR – proliferative vitreoretinopathy; SO – silicon oil.

Table 2: The anatomical and functional outcome of the whole cohort of patients.

Variable	Patients (n=88)
Anatomical outcome after primary PPV, n (%)	82 (93.2%)
Final anatomical outcome	88 (100%)
Preoperative BCVA, mean ± SD; range (logMAR)	1.7 ± 1.2; 0–4*
Postoperative BCVA, mean ± SD; range (logMAR)	0.6 ± 0.7; 0–3*

Legend: *p = 0.01; PPV – pars plana vitrectomy; BCVA – best corrected visual acuity; SD – standard deviation.

had preoperative PVR grade ≥ C1. The average AL of the operated eyes was 24.7 mm (range 21.2–32.4 mm) (Table 1).

Sixty-eight patients (77%) received endotamponade with air-gas mixture, eighteen patients (21%) received SO, and an air endotamponade was used in two cases (2%) (Table 1). Four patients with gas endotamponade and re-detachment after primary PPV received SO as an endotamponade in the second intervention. The follow-up period ranged from 6–24 months.

3.2 Anatomical and functional outcome

The anatomical success after a primary vitrectomy was achieved in 82 out of 88 of patients (93.2%). Six patients needed repeated surgery due to retinal re-detachment. After the second surgery, final retinal reattachment was achieved in all 88 eyes (100%) (Table 2). Improvement from preoperative BCVA 1.7 ± 1.2 SD logMAR to postoperative BCVA 0.6 ± 0.7 SD (p=0.01; paired t-test) showed statistical significance (Table 2). BCVA improved in 76.14% (67 patients) after the surgical procedure, while BCVA remained the same in seven patients (7.9%). BCVA was slightly worse in 15.9% (14 patients) after the surgery. The cause of transiently poorer BCVA after PPV was a cataract in seven patients and fibrosis of the posterior lens capsule in two patients. BCVA was permanently worse in two patients with ERM and in three patients due to EZ discontinuity after retinal re-detachment.

The group of patients with their own crystalline lens and the group with IOL did not differ in anatomical outcome. The anatomical outcome was worse in the group of patients with macula-on detachments in comparison to the group with macula-off detachment. However, a significantly smaller number of patients were included in the group of patients with macula-on detachments. Therefore, a statistical comparison between the groups did not make sense. The anatomical outcome was worse in the group of patients with PVR grade ≥ C1 than in the group without PVR (Table 3).

Table 3: A comparison of anatomical outcome according to the groups based on crystalline lens status, macular status and presence of preoperative (PVR).

	Anatomical outcome, n (%)
Crystalline lens status • Phakic (n=53; 60.2%) • Pseudophakic (n=32; 36.4%) and aphakic (n=3; 3.4%)	 50 (94.34%) 33 (94.29%)
Macular status • Macula-on (n=20; 23%) • Macula-off (n=68; 77%)	 18 (90.00%) 64 (94.12%)
Presence of PVR grade ≥ C1 • No PVR (n=59; 67%) • PVR grade ≥ C1 (n=29; 33%)	 56 (94.19%) 26 (89.67%)

Legend: PVR – proliferative vitreoretinopathy.

Postoperative BCVA improved in all groups of patients, but after analysis according to the groups, statistically significant improvement was found in the phakic group (p=0.019), macula-off group (p=0.016), and the group with PVR grade ≥ C1. The absolute value of BCVA improved the most in macula-off group (for 1.88 logMAR) and the least in macula-on group (for 0.22 logMAR). Improvement of absolute value of BCVA was the same in the phakic and pseudophakic groups (for 1.35 logMAR) and very similar between the groups with and without PVR grade ≥ C1 (1.44 logMAR in group without PVR; 1.48 logMAR in group with PVR grade ≥ C1) (Table 4).

3.3 Postoperative OCT analysis

Postoperative OCT macular analysis showed CME in 15% of cases, ERM in 2%, MH in 2% and EZ discontinuity in 39% (Table 5). A comparison between the groups according to the crystalline lens status showed a slightly higher proportion of CME (17.1%) and EZ discontinuity (45.7%) in pseudophakic patients. A comparison between the groups according to the preoperative macular status showed the highest proportion of CME (15%) in patients with macula-on, while the proportion of EZ discontinuity was similar between the macula-on and -off groups (40% in patients with

Table 4: A comparison of functional outcome according to the groups based on crystalline lens status, macular status and presence of preoperative proliferative vitreoretinopathy (PVR).

	Preoperative BCVA (logMAR)	Postoperative BCVA (logMAR)	p-value
Crystalline lens status			
• Phakic (n=53; 60.2%)	2.56 ± 0.99	1.21 ± 1.19	0.019*
• Pseudophakic (n=32; 36.4%) and aphakic (n=3; 3.4%)	2.1 ± 1.21	0.75 ± 1.06	0.286
Macular status			
• Macula-on (n=20; 23%)	1.00 ± 1.50	0.78 ± 1.30	0.374
• Macula-off (n=68; 77%)	3.0 ± 0.74	1.12 ± 1.05	0.016*
Presence of PVR grade ≥ C1			
• No PVR (n=59; 67%)	2.24 ± 1.22	0.80 ± 1.15	0.235
• PVR grade ≥ C1 (n=29; 33%)	2.75 ± 0.58	1,27 ± 1.10	0.028*

Legend: * p<0.05; BCVA – best-corrected visual acuity; PVR – proliferative vitreoretinopathy.

macula-on and 38.2% in patients with macula-off detachments). A comparison between the groups according to the presence of PVR showed the highest proportion of CME (20.7%) and EZ discontinuity in the group of patients with the presence of preoperative PVR grade ≥ C1 (58.6%) (Table 6).

4 Discussion

Advanced modern surgical techniques and approaches provide high rates of successful anatomical outcome in patients after PPV for RRD. However, functional outcome is variable despite high anatomical success rate. Morphological preoperative factors that are most commonly associated with worse postoperative functional and anatomical outcome are macula-off detachment (6,11-14) and preoperative PVR (6,15,16). Predictive factors for functional outcome are also BCVA and duration of symptoms before surgery (7). Modern diagnostic methods for analysis of macular condition with OCT provide insight into structural analysis of retinal layers, which can be, used to partly predict functional outcome, depending on the morphological changes (26).

Table 5: Analysis of postoperative OCT macular imaging of the whole cohort of patients.

OCT variable	Frequency, n (%)
OCT – presence of CME	
• No	75 (85%)
• Yes	13 (15%)
OCT – presence of ERM or MH	
• ERM	2 (2.3%)
• MH	2 (2.3%)
OCT – EZ discontinuity	
• No discontinuity	54 (61%)
• Discontinuity	34 (39%)
OCT – central retinal thickness (µm)	274 ± 75.5 (range: 113 – 606)

Legend: CME – cystoid macular oedema; MH – macular hole; ERM – epimacular membrane; EZ – ellipsoid zone; n – number.

In our retrospective analysis of 88 patients after PPV for RRD, the anatomical success rate was 93.2% which is comparable to the previous reports (3-6).

Postoperative BCVA improvement was statistically significant in comparison to preoperative BCVA (from 1.7 ± 1.2 SD logMAR to 0.6 ± 0.7 SD logMAR). The improvement of BCVA was similar to the study of Dugas et al., in which preoperative BCVA improved from 1.42 ± 0.81 SD logMAR to 0.72 ± 0.7 SD logMAR postoperatively (5). In contrast to Heimann's study, the proportion of patients with improved BCVA postoperatively was higher (76% patients in our study; 46.1% in Heimann's study), while the proportion of patients with slightly worse postoperative BCVA was similar in both studies (15.9% in our study; 12.7% in Heimann's study) (4). Otherwise, the study of Heimann et al. was performed on a larger number of patients (512 patients) as compared to our study (88 patients) (4).

The anatomical outcome in our study did not differ between the group of phakic and pseudophakic patients (94.34% and 94.29% respectively). Kapran et al. showed statistically significant difference in anatomical outcome between pseudophakic and phakic patients with better anatomical outcome in pseudophakic patients

Table 6: Analysis of OCT macular imaging according to the groups based on lens status, macular status and proliferative vitreoretinopathy (PVR).

	Preoperative BCVA (logMAR)	Duration of symptoms (days)	OCT – presence of CME (n; %)	OCT – presence of discontinuity of EZ (n; %)	OCT – central retinal thickness (µm; ± SD. range)
Crystalline lens status • Phakic (n=53; 60.2 %) • Pseudophakic (n=32; 36.4 %) and aphakic (n=3; 3.4 %)	2.56 ± 0.99 2.1 ± 1.21	28.8 ± 80.0 26.5 ± 53.0	7 (13.2 %) 6 (17.1 %)	18 (34 %) 16 (45.7 %)	271.4 ± 65.7 (113–515) 282.7 ± 88.7 (141–606)
Macular status • Macula-on (n=20; 23%) • Macula-off (n=68; 77%)	1.00 ± 1.50 3.0 ± 0.74	23.6 ± 45.5 29.1 ± 76.2	3 (15 %) 10 (14.7 %)	8 (40 %) 26 (38.2 %)	279.1 ± 97.8 (113–515) 273.4 ± 68.5 (186–606)
Presence of PVR grade ≥ C1 • No PVR (n=59; 67%) • PVR grade ≥ C1 (n=29; 33%)	2.24 ± 1.22 2.75 ± 0.58	11.9 ± 26.7 60.4 ± 110.5	7 (11.9 %) 6 (20.7 %)	17 (28.8 %) 17 (58.6 %)	273.4 ±71.3 (113–515) 275.5 ± 85.3 (203–606)

Legend: BCVA – best-corrected visual acuity; SD – standard deviation n – number; CME – cystoid macular oedema; PVR – proliferative vitreoretinopathy.

(91.3%) than in phakic patients (61.53%) after PPV for non-complex RRD. However, in Kapran's study only 36 eyes were included and they were predominantly pseudophakic (64%) (27), while our analysis was performed with a larger number of patients (88 eyes), which were mostly phakic (60%). In contrast to Kapran's study, Wickham et al. found a higher anatomical failure rate in pseudophakic patients after PPV for RRD, but the association was not statistically significant (16). The influence of lens status on functional outcome was studied by Pastor and Gerding, who did not show statistically significant association (6,11).

In this study, we showed the statistically significantly higher improvement of the absolute value of BCVA in eyes with macula-off detachments as compared to eyes with macula-on detachments. In the latest group the improvement of the absolute value of BCVA was lower and statistically unsignificant. This finding is logical and expected. Similarly, Cheng et al. also found a higher improvement of the absolute value of BCVA in the group with macula-off detachments than in the group with macula-on detachments. The most likely explanation for such an improvement is better preoperative BCVA in the group of macula-on detachments than in the macula-off detachments (18). Similar to our results, Pastor's and Gerding's also described worse final postoperative BCVA in eyes with macula-off RRD. The proportions of eyes with macula-off detachment were higher in both studies than the proportions of eyes with macula-on detachment, (77% in our study, 65% in Pastor's, 80% in Gerding's) (6,11). Subgroup analysis showed better final BCVA in pseudophakic patients, patients with macula-on detachment, and patients without PVR. Despite the differences in pre- and postoperative BCVA, the final postoperative BCVA in eyes with macula-on detachment was much better than in eyes with macula-off detachment.

In our cohort of patients, preoperative PVR grade ≥ C1 was present in one-third of eyes (33%) and was similar to Pastor's (24–43%), Wickham's (29%), and Mitry's studies (36.5%) (6,15,16). The anatomical outcome was slightly worse in the group of eyes with preoperative PVR (89.7%) compared to the group without PVR (94.1%). An association between anatomical failure and preoperative PVR has been supported in previously published studies (15,16). Mitry reported a two-fold increase in the anatomical failure rate in cases of preoperative PVR of any grade (15).Wickham found a statistically significant association between anatomical failure and preoperative PVR grade C in addition to previously performed cataract surgery and an extent of retinal detachment (16). Heimann and Pastor found a statistically significant association between preoperative PVR and functional outcome (4,6). Heimann found a statistically significant association between PVR grade ≥ B and worse functional outcome in a

group of 512 patients (4). In Pastor's study, preoperative presence of PVR grade A or B was associated with worse functional outcome but not with worse anatomical outcome (6). Our patients with PVR grade ≥ C1 also had significantly worse functional outcome compared to patients without PVR (1.27 ± 1.10 and 0.80 ± 1.15 respectively).

Worse postoperative BCVA, despite anatomical success, could be partly explained with an analysis of morphological macular changes on OCT. During analysis of macular OCT in our study, the EZ discontinuity was found in the highest proportion (39%), while CME (15%), ERM (2%), and MH (2%) were found in much smaller proportions. In the subgroup analysis, the highest proportion of patients with CME was in the group with preoperative PVR grade ≥ C1. The CRT value did not significantly differ between the groups. The proportion of eyes with EZ discontinuity in our study was similar as described by Cho (40% of eyes out of 12) and Delolme (53% of eyes out of 30) (28,29), while Schocket reported a higher proportion of eyes with EZ discontinuity (82% out of 17) (26).

Furthermore, in our study we compared the EZ continuity between different groups of patients. The highest proportion of EZ discontinuity was present in the group of patients with preoperative PVR (58.6%). Surprisingly, the proportion of EZ discontinuity between the groups of patients with macula-on (40%) and macula-off (38.2%) was not significantly different. Due to different numbers of patients included in these two groups (the number in the macula-off group was more than threefold higher compared to the macula-on group of patients, 20:68 patients), this finding is not reliable. In our opinion, the probability of macula-off detachment in patients with complex RRD and longer duration of symptoms, is significantly higher than it can be confirmed during clinical examination with either indirect ophthalmoscopy or biomicroscopy. Retinal detachment in the central part of the retina (central fovea) can be shallow and also overlooked regarding numerous structural retinal changes. Based on the results of our study, we believe that it would be very advantageous to perform OCT macular imaging preoperatively in all patients with RRD whenever technically feasible. This would allow a more accurate assessment of the preoperative condition and a more accurate prediction of the functional outcome of the surgery.

Worse functional outcome because of EZ discontinuity was described in numerous previous reports (17-21,26). In PIONEER research performed on a sample of fifteen patients, the integrity of EZ was associated with better functional outcome twelve months after surgery (17). Similar findings were described by Cheng et al. on a sample of forty-three patients with at least five-month follow-ups (18). Kobayashi showed from a sample of twenty-nine patients that the integrity of EZ two weeks after a vitrectomy was a predictive factor for final BCVA one year postoperatively (19). Significant association between the thickness of complex EZ - retinal pigment epithelium and BCVA one month after surgery was also described by Dell'Omo in Terauchi (20,21). In our study the highest proportion of patients with EZ discontinuity was present in the group of patients with PVR grade ≥ C1. For patients in this group the symptoms, on average, lasted longer (60.4 ± 110.5 days), they had higher proportions of postoperative CME (20.7%), higher proportions of EZ discontinuity (58.6%), and they had the worst functional outcome. Postoperative BCVA in this group was 1.27 ± 1.10 logMAR (Table 4). In our opinion, worse anatomical and functional outcome of the treatment in this group is very indicative. The symptoms also lasted for a longer time in the patients of this group (60 days on average). Such cases can remind us that patients' access to urgent ophthalmological examination as well as surgical treatment is essential for the successful outcome of the treatment.

Our study has some limitations. The biggest limitation is its retrospective design. The samples of patients divided into groups were small. The advantage of our study is that patients who underwent surgery with the same surgical method (PPV) were included. The selection criteria were strict. On the contrary, many studies have included various surgical methods of treatment for retinal detachment, which makes the interpretation of the findings less reliable.

Analysis of the macular area with OCT after the surgery indicates the most frequent morphological changes in outer retinal layers, such as EZ discontinuity and also CME. Preoperative OCT imaging in all patients with retinal detachment would enable a more accurate comparison of changes in the macula and might allow us even more detailed insight into complex mechanisms that have a significant influence on anatomical and functional outcome. Further studies with a larger number of patients as well as a clearer definition of the selection criteria would be desirable.

5 Conclusion

Our results showed highly successful anatomical outcome in eyes after primary PPV for RRD and statistically significant improvement of visual function.

Comparison between the groups according to crystalline lens status, macular status, and presence of PVR grade ≥ C1 showed the worst anatomical outcome in group of patients with PVR grade ≥ C1. Postoperative BCVA improvement was statistically significant in patients with natural crystalline lens, macula-off detachments, and the presence of PVR grade ≥ C1. During a structural analysis of retinal layers on OCT we found a large proportion of patients with postoperative EZ discontinuity. Comparison between the groups showed the highest proportion of EZ discontinuity in patients with PVR grade ≥ C1 and a similar proportion of EZ discontinuity in patients with macula-on and macula-off detachments. The final BCVA had pseudophakic patients, patients with macula-on detachments, and patients without PVR.

According to the findings of our study, for a more accurate determination of macular condition and better prediction of functional outcome, it would make sense to perform preoperative OCT on all patients with RRD. Retinal detachment is an ophthalmic emergency. Patients with retinal detachment must be referred to an ophthalmologist in a timely manner. Access to ophthalmological examination with prompt and appropriate treatment are important factors for successful management of patients with RRD.

Conflict of interest

None declared.

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