ORIGINAL ARTICLES

UDC: 617.7-089
DOI: 10.2298/VSP141001175K

Anatomical and functional factors influencing the results of scleral buckling procedure for macula-off rhegmatogenous retinal detachments

Anatomski i funkcionalni faktori koji utiču na rezultate klasične hirurške procedure kod bolesnika sa regmatogenom ablacijom retine

Igor Kovačević*†, Aleksandra Radosavljević*†, Ivan Stefanović*†, Bojana Radović*, Jelena Karadžić*, Dragana Kovačević Pavićević*†, Olgica Djurković-Djaković‡

***Clinic for Eye Diseases, Clinical Centre of Serbia, Belgrade, Serbia; †Faculty of Medicine, University of Belgrade, Belgrade, Serbia; ‡Institute for Medical Research, University of Belgrade, Belgrade, Serbia**

Abstract

Background/Aim. Rhegmatogenous retinal detachment is a potentially blinding condition of the posterior segment of the eye. Currently, the only treatment modality is surgery and surgical options include scleral buckling, *pars plana* vitrectomy and pneumoretinopexy. Many factors may influence the outcome of the surgery. Well defined indications are essential for achieving the best postoperative results. The aim of this study was to assess anatomical and functional outcome of treatment with scleral buckling for macula-off rhegmatogenous retinal detachments. **Methods.** This prospective, nonrandomized, interventional study included consecutive patients underwent scleral buckling for macula-off retinal detachment in the tertiary centre for vitreoretinal surgery. **Results.** A total of 168 consecutive patients (mean age 58.2 ± 13.9 years) were included in the study. Postoperatively, anatomical success was achieved in 152 (90.5%) of the patients. Parameters that influenced the anatomical success included the number of retinal breaks ($p = 0.040$), lens status ($p = 0.041$), preoperative proliferative vitreoretinopathy ($p < 0.001$), patients' age ($p = 0.049$), and marginally, the presence of typical symptoms ($p = 0.057$). Duration of macular detachment, previous ocular trauma and refraction of the eye did not affect the anatomical result. Functional success was evaluated using the postoperative visual acuity and depended mainly on the duration of macular detachment prior the surgery. Visual acuity 0.4 or better was significantly more often achieved if duration of macular detachment was up to seven days ($p < 0.001$). Refraction and patients' age did not influence the functional result. **Conclusion.** Scleral buckling is an efficient surgical procedure for treatment of patients with retinal detachment. Optimal results are achieved if operation is performed within the first seven days of duration of macular detachment.

Key words:
retinal diseases; retinal detachment; ophthalmologic surgical procedures; treatment outcome.

Apstrakt

Uvod/Cilj. Regmatogena ablacija retine je oboljenje zadnjeg segmenta oka koje, ako se ne leči, može dovesti do slepila. Trenutno, jedini način lečenja je hirurški i opcije su klasična metoda (*scleral buckling*), *pars plana* vitrektomija i pneumoretinopeksija. Mnogi faktori mogu uticati na ishod operacije. Jasno definisane hirurške indikacije su ključne za postizanje dobrih postoperativnih rezultata. Cilj ove studije bio je da se procene faktori koji utiču na anatomski i funkcionalni ishod lečenja klasičnom metodom lečenja bolesnika sa regmatogenom ablacijom retine sa zahvaćenom makulom. **Metode.** U prospektivnu, nerandomizovanu, interventnu studiju bili su uključeni svi bolesnici operisani klasičnom metodom zbog ablacije retine sa zahvaćenom makulom, u tercijarnom centru za vitreoretinalnu hirurgiju. **Rezultati.** Ukupno 168 bolesnika (starosti 58,2 ± 13,9 godina) bilo je uključeno u studiju. Postoperativno, anatomski uspeh postignut je kod 152 (90,5%) bolesnika. Parametri koji su uticali na anatomski uspeh operacije bili: su broj ruptura retine ($p = 0,040$), status sočiva ($p = 0,041$), preoperativno prisustvo proliferativne vitreoretinopatije ($p < 0,001$), starost ($p = 0,049$) i, granično, prisustvo tipičnih simptoma ($p = 0,057$). Dužina odvojenosti makule, ranije povrede oka i refrakcija oka nisu uticali na anatomski rezultat. Funkcionalni uspeh procenjivan je na osnovu postoperativne vidne oštrine i zavisio je uglavnom od preoperativne dužine trajanja odvojenosti makule. Vidna

Correspondence to: Olgica Djurković-Djaković, Institute for Medical Research, University of Belgrade, Dr. Subotića 4 P.O. Box 102, 11 129 Belgrade, Serbia. Phone: +381 11 2685 788. E-mail: olgicadj@imi.bg.ac.rs

oštrina 0,4 ili bolja bila je značajno češće postignuta ako je dužina trajanja odvojenosti makule bila do sedam dana ($p < 0,001$). Refrakcija oka i životno doba bolesnika nisu uticali na funkcionalni ishod operacije. **Zaključak.** Klasična metoda *scleral buckling* je efikasna hirurška procedura za nekomplikovane slučajeve ablacije retine. Kada je makula zahvaćena, najbolji rezultati postižu se operacijom u toku prvih sedam dana od početka simptoma.

Ključne reči:
retina, bolesti; retina, ablacija; hirurgija, oftalmološka, procedure; lečenje, ishod.

Introduction

Rhegmatogenous retinal detachment (RD) is a potentially blinding condition of the posterior segment of the eye that develops as a result of full-thickness retinal defects that allow liquefied vitreal gel to reach into the subretinal space and detach neurosensory retina from the retinal pigment epithelium (RPE) [1]. The only current treatment is surgery, and surgical procedures include scleral buckling (SB), pars plana vitrectomy (PPV) and pneumoretinopexy [2]. Well defined surgical indications are essential for achieving the best postoperative results. Anatomical restitution rates after both SB and PPV are over 90% [3–5]. Clinical features and prognosis of RD mainly depend on the presence of detachment of neurosensory retina in the macular area [6, 7]. In macula-off RD cases, despite the successful surgical repair and excellent anatomical results, functional recovery is limited by the time-dependent damage of the photoreceptors in the macular area [7]. Restitution of visual acuity is possible, but is most commonly incomplete and therefore, time elapsed between macular detachment and surgery, known as duration of macular detachment (DMD), is critical for postoperative results [8].

As mentioned, precisely defined indications and excellent surgical technique are essential for successful postoperative results. There is a long tradition of RD surgery in Serbia, with the first surgical procedure performed in 1926. The most prominent vitreoretinal surgeons that were masters of those methods and teachers of nowadays Serbian ophthalmologists are Milan Blagojević, Zlatimir Kecmanović, Vasilije Misita and Miloš Ignjačev [9–11].

The aim of this study was to evaluate the results of SB for the repair of rhegmatogenous macula-off RD, with the emphasis on the influence of DMD on postoperative anatomical results and visual function.

Methods

A prospective, nonrandomized, interventional study included consecutive patients hospitalized for macula-off RD between January 1, 2013 and December 31, 2013, who had SB performed at the single referral centre for vitreoretinal surgery in Serbia. The patients underwent complete ophthalmological examination including medical history, best corrected visual acuity (BCVA) assessment (measured by Snellen chart at 6 m and converted to decimal notation), applanation tonometry, slit lamp examination and indirect ophthalmoscopy with 90D and 20D lens. DMD was established for each patient, as the period between the onset of decreased vision and surgery.

Only patients with uncomplicated rhegmatogenous RD involving macula were analyzed in the study. The exclusion criteria were complicated cases of RD [multiple retinal breaks in more than two quadrants, giant tears, posterior breaks unreachable for SB or extensive proliferative vitreoretinopathy (PVR), who were operated by PPV], ocular pathology that might affect visual acuity (amblyopia, glaucoma, corneal pathology, macular diseases, previous vitreoretinal surgery), and persons in whom visual function could not be assessed (neurological or psychiatric diseases). The last two groups were operated either by SB or PPV, but were not analyzed in the study (19 and 5 cases, respectively).

SB was performed under general anesthesia, according to a standardized protocol which included localization of the retinal breaks using indirect ophthalmoscopy, transscleral cryopexy of the breaks and suturing of an encircling silicone band and silicon explant, that corresponded in size and localization to the position of the breaks, to the sclera. External drainage of subretinal fluid was not performed due to the risk of potential complications [12].

The postoperative outcome was evaluated three months after surgery and included anatomical and functional results. Anatomical result of the surgery was classified as retina reattached to the RPE or persistent RD. The functional result was assessed using the difference in pre- and postoperative best corrected visual acuity.

The study followed the tenets of the Declaration of Helsinki, and was approved by the Ethics Committee of the Clinical Centre of Serbia.

Data were analyzed using SPSS 15.0. Comparison of categorical variables, such as DMD groups, history of eye trauma, symptoms of RD, number of retinal breaks, the presence of PVR, lens status, refraction of the eye and age groups, was carried out using χ^2 or Fisher test (as appropriate). Comparison of numerical variables, such as change in pre- and postoperative BCVA, was performed using the general linear model for repeated measures (with Bonferroni's adjustment). The level of statistical significance was 0.05.

Results

The study involved a total of 168 patients who underwent SB for macula-off RD and fulfilled other inclusion criteria. Demographic and clinical findings of patients are presented in Table 1.

According to the anatomical outcome, the majority of the patients (90.5%) had retinal reattachment achieved, while 9.5% patients had persistent RD (Table 1). Comparative analysis of their characteristics (Table 2) showed that significantly better anatomical results were achieved in

Table 1

Demographic and clinical characteristics of 168 patients underwent scleral buckling (SB) for macula-off retinal detachment (RD)

Variable	Values
Sex, n (%)	
male	97 (57.7)
female	71 (42.3)
Age in years, $\bar{x}$ ± SD (range)	58.2 ± 13.9 (8–83)
Age in years, n (%)	
< 50	32 (19.0)
50–65	87 (51.8)
> 65	49 (29.2)
Affected eye, n (%)	
right	89 (53.0)
left	79 (47.0)
Refraction of the affected eye, n (%)	
emmetropia	124 (73.8)
hyperopia	1 (0.6)
myopia	43 (25.6)
≥ - 3 D	9 (5.4)
< - 3 and ≥ - 6 D	13 (7.7)
< - 6 D	21 (12.5)
Lens status, n (%)	
transparent	112 (66.7)
cataract	24 (14.3)
pseudophakia	26 (15.5)
aphakia	6 (3.6)
History of ocular trauma, n (%)	
no	157 (93.5)
yes	11 (6.5)
Typical symptoms of RD, n (%)	
none	111 (66.1)
present	57 (33.9)
Number of retinal breaks	
1	103
2	28
3	18
≥ 4	19
PVR, n (%)	
present	13 (7.7)
absent	155 (92.3)
DMD (days), range	
DMD (days), n (%)	2–90
1–10	37 (22.0)
1–4	7 (4.2)
5–7	12 (7.1)
8–10	18 (10.7)
11–30	76 (45.2)
> 30	55 (32.7)
Anatomical outcome of SB, n (%)	
reattached retina	152 (90.5)
residual RD	16 (9.5)
BCVA of the affected eye, $\bar{x}$ ± SD	
at admission	0.15 ± 0.24
90 days post SB	0.27 ± 0.25
p value	< 0.001

n – number of patients; $\bar{x}$ – mean; SD –standard deviation; PVR – proliferative vitreoretinopathy; DMD – duration of macular detachment; BCVA – best corrected visual acuity.

Table 2

Anatomical outcome of scleral buckling (SB) in patients with macula-off retinal detachment (RD) according to baseline clinical characteristics

Variable	Patients, n (%)		*p*
	reattached retina	persistent RD	
DMD (days)			
1–10	33 (89.2)	4 (10.8)	
11–30	70 (92.1)	6 (7.9)	0.807
> 30	49 (89.1)	6 (10.9)	
History of ocular trauma			
yes	10 (90.9)	1 (9.1)	0.960
no	142 (90.4)	15 (9.6)	
Typical symptoms of RD			
present	55 (96.5)	2 (3.5)	0.057
none	97 (87.4)	14 (12.6)	
Number of retinal breaks			
1	97 (94.2)	6 (5.8)	0.040
≥ 2	55 (84.6)	10 (15.4)	
PVR			
present	7 (53.8)	6 (46.2)	< 0.001
absent	145 (93.5)	10 (6.5)	
Lens status			
transparent	105 (93.8)	7 (6.2)	0.041
cataract or post cataract surgery	47 (83.9)	9 (16.1)	
Refraction of the affected eye			
emmetropia and hyperopia	112 (89.6)	13 (10.4)	0.509
myopia	40 (93.0)	3 (7.0)	
Age (years)			
< 50	26 (81.2)	6 (18.8)	0.049
50–65	83 (95.4)	4 (4.6)	
> 65	43 (87.8)	6 (12.2)	

PVR – proliferative vitreoretinopathy; DMD – duration of macular detachment.

patients with a single retinal break ($p = 0.040$), without PVR ($p < 0.001$), with a transparent lens ($p = 0.041$) and in those 50–65 years old ($p = 0.049$). The outcome in the patients presenting typical symptoms (flashes of light, floaters and visual field defects) was better but this difference was only close to statistically significant ($p = 0.057$). On the other hand, parameters including DMD, the history of ocular trauma and refraction of the eye did not affect the anatomical result of SB ($p > 0.05$).

Among 152 of the patients who achieved retinal reattachment, we further investigated functional outcome. The change in the BCVA between admission and 90 days post-SB was used as a parameter of functional recovery. Overall, a significant increase in visual acuity was observed ($p < 0.001$) (Table 1). The patients with shorter DMD (≤ 10 days) had significantly better both preoperative and post-SB BCVA compared to those with DMD 11–30 days ($p = 0.001$) or > 30 days ($p < 0.001$) (Table 3). On the other hand, there was no difference in post-SB BCVA between patients with DMD 11–30 and > 30 days. The DMD group 1 was further divided into subgroups with DMD 1–4, 5–7 and

Table 3

Functional outcome of scleral buckling (SB) in patients with macula-off retinal detachment (RD) according to duration of macular detachment (DMD)

DMD (days)	BCVA, $\bar{x} \pm SD$		$p^{\#}$
	at admission	90 days post SB	
1–10	0.29 ± 0.33	0.42 ± 0.28	< 0.001
11–30	0.12 ± 0.21***	0.26 ± 0.24**	< 0.001
> 30	0.09 ± 0.16	0.18 ± 0.18	0.001
1–4	0.44 ± 0.35	0.51 ± 0.28	0.427
5–7	0.35 ± 0.34	0.53 ± 0.25	0.013
1–7	0.39 ± 0.34	0.52 ± 0.25	0.012
8–10	0.18 ± 0.30*	0.30 ± 0.26**	0.034
1–7	0.39 ± 0.34	0.52 ± 0.25	0.001
8–30	0.13 ± 0.23***	0.26 ± 0.24***	< 0.001
> 30	0.09 ± 0.16	0.18 ± 0.18	0.001

#p* – value between best corrected visual acuity (BCVA) at admission and 90 days post-SB; *,**,, statistical significance at level $p < 0.05, < 0.01, < 0.001$, respectively, *vs* previous entry in column; $\bar{x}$ – mean; SD – standard deviation.**

8–10 days (comprising 7, 12 and 18 patients respectively), among which no difference in post-SB BCVA was observed (Table 3), presumably due to a small number of patients and consequential lack of statistical power. As the BCVA was quite similar in DMD subgroups 1–4 and 5–7 days, they were aggregated and compared to the 8–10 days DMD subgroup, and significantly higher both preoperative and post-SB visual acuities were observed in the 1–7 days subgroup (Table 3). Therefore, patients from DMD subgroup 8–10 days were added to those in DMD 11–30 days group, and BCVA was analyzed in the transformed groups (1–7, 8–30 and > 30 days). The patients with the shortest DMD had a significantly better visual recovery ($p < 0.001$) (Table 3).

Finally, analysis of to the postoperative visual function showed that BCVA 0.4 or better was more likely to be reached in patients with DMD 1–7 days (72.2%), as compared to DMD 8–30 (23.5%) and > 30 days (16.3%) ($p < 0.001$) (Table 4).

when compared to multiple breaks, was associated with better anatomical result, confirming that multiple breaks increase the risk for failure of SB [8, 16, 19]. It is more likely to overlook a retinal break or fail to seal them all, in cases with multiple breaks. Early PVR was a significant predisposing factor for unfavourable anatomical outcome [7, 17]. PVR restricts the retina and SB cannot prevent this process. In cases with extensive proliferative vitreoretinopathy, PPV should be performed.

An association of anatomical success with the presence of typical symptoms may be expected since those patients were operated earlier and had a lower chance of developing retinal changes including PVR. Indeed, significantly better anatomical results in the presence of typical symptoms (82% and 77% respectively, $p = 0.014$), were shown in the MUSTARD study [1]. We achieved anatomical success in 96.5% of the patients with typical symptoms *vs* 87.4% of those who did not present symptoms. However, this difference was only marginally significant.

Table 4

Functional outcome of scleral buckling (SB) 90 days post-SB in 152 patients with anatomic success according to the duration of macular detachment (DMD)

DMD (days)	Patients, n (%)		*p*
	BCVA ≥ 0.4	BCVA < 0.4	
1–7	13 (72.2)	5 (27.8)	
8–30	20 (23.5)	65 (76.5)	< 0.001
> 30	8 (16.3)	41 (83.7)	
Total	41 (27.0)	111 (73.0)	

BCVA – best corrected visual acuity.

The functional results of SB were the same in patients with different refractive errors ($p > 0.05$). Emmetropic (including one hyperopic patient) and myopic patients alike achieved significantly better post-SB BCVA ($p < 0.001$). The patients below 50 years of age had better preoperative BCVA when compared to those older than 65 years ($p = 0.047$). Postoperative BCVA, although better than the initial one in all age groups, did not differ significantly.

Discussion

SB is a conventional surgical procedure for the repair of uncomplicated RD. The rate of anatomical success in the presented series was 90.5%. This is comparable to 94% and 88.5% the data of bicenter studies by Pastor et al. [13], and Falkner-Radler et al. [14] respectively, and even better 80.4% than the large multicenter MUSTARD study [1].

The anatomical success rate did not depend on DMD, ocular trauma and refraction of the eye, but depended on the number of retinal breaks, the presence of PVR, lens status and patients' age and marginally on the presence of typical symptoms. These results, with small differences, confirm previous findings [7, 15–19]. We did not find any difference in anatomical success in the groups of patients with different refractive errors. Interestingly, the MUSTARD study reported better anatomical results in moderate myopes (-2.75 to -8 dioptres, 86.7%) [18]. The presence of a single retinal break

Patients with a transparent lens had a significantly higher rate of retinal reattachment than those with cataract or previous cataract surgery. The presence of cataract in phakic or capsule opacities in pseudophakic eyes can reduce visualisation of peripheral retina and make the detection of retinal breaks more difficult. Therefore, those patients can have poorer surgical outcomes, as shown by Vukosavljević et al. [20]. However, Thelen et al. [1] reported equal success in patients with a natural lens, aphakia and pseudophakia (80.49%, 79.18% and 81.95% respectively), but the results could not be compared since their study did not analyze patients with natural lens according to its transparency.

The best anatomical results were achieved in patients of 50–65 years of age. In contrast, in the study of Hassan et al. [21] no significant difference was observed in the rate of retinal reattachment in different age groups (≤ 60, 61–75 and > 75 years of age). Thelen et al. [1] reported that the best anatomical results were achieved in the younger age group (21–30 years; 87.79%) and poorest in children up to 10 years (77%) and very old patients (71–80 and 81–90 years; 74.07% and 70.48% respectively). The great diversity of reported results warrants further investigations.

In patients with anatomical success, functional results were analysed. Many preoperative factors including visual acuity [6, 7, 19, 22], DMD [6, 8, 19, 21], height of RD [22], vitreomacular traction [12], as well as postoperative factors including epireti-

nal membranes [23] and persistent submacular fluid [22–24] can influence visual recovery. Functional results mainly depend on the time lapse between the separation of neurosensory retina from the RPE in the macular area and surgical repair. In our series, the best functional recovery was achieved if SB was performed within the first 7 days after the symptoms occured. After that period postoperative BCVA decreased significantly. Postoperative visual acuity was significantly higher than preoperative BCVA in all patients irrespective of DMD, except for the patients with 1–4 days of DMD. In this group, improvement in visual acuity did not reach statistical significance due to good initial BCVA. Postoperative visual acuity was equally good within the period of 1–7 days of DMD and the majority of these patients (72%) achieved visual acuity of 0.4 or better (mean BCVA 0.52). Previous studies reported shorter, equal or longer DMDs as critical for the satisfactory postoperative results, including 3 [25], 6 [8], 7 [3, 7, 15] and 10 days [21]. In a series of 96 patients, Liu et al. [15] reported a BCVA ≥ 0.4 achieved in 68% of patients with DMD of 1–7 days (mean BCVA 0.45) and concluded that postoperative BCVA was the same within this period. On the other hand, Hassan et al. [21] analyzed 94 patients with macula-off RD and concluded that DMD of 1–10 days was a significant period for satisfactory functional results (when compared to DMD groups 11 days to 6 weeks and > 6 weeks). In our study, the patients with DMD 1–10 days had overall better visual recovery, but when stratified into subgroups of 1–7 and 8–10 days, a significantly better postoperative BCVA was observed in favor of DMD 1–7 days. Diederen et al. [8] reported similar findings, concluding that the critical DMD was 6 days.

Refraction of the eye did not affect the postoperative BCVA and in all groups significant improvement was achieved. However, Yang et al. [26] reported that low grade myopic patients (up to -6 D) regained significantly better postoperative visual acuity as compared to both high grade myopic (> -6 D) and emmetropic patients.

Functional outcome of SB did not differ among the age groups, although it was slightly better in younger patients due to the best preoperative BCVA. The fact that functional results are better in younger patients has been shown in studies of Pastor et al. [13] and Hassan et al. [21].

Conclusion

SB is an efficient surgical procedure for uncomplicated macula-off rhegmatogenous RD cases with a single retinal break, transparent lens and without PVR. The presented results show that equally good postoperative results are achieved if operation is performed at any time within the first seven days of DMD, whereas after this period functional recovery significantly decreases.

Acknowledgement

The work was supported by the project (grant No. III41019) from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Declaration of interest

Authors declare no conflict of interest.

REFERENCES

1. *Thelen U, Amler S, Osada N, Gerding H*. Outcome of surgery after macula-off retinal detachment - results from MUSTARD, one of the largest databases on buckling surgery in Europe. Acta Ophthalmol 2012; 90(5): 481−6.
2. *Kreissig I*. Surgical techniques for repair of primary retinal detachment: part I. Review of their development during the last 80 years. Folia Med 2009; 51(4): 5−11.
3. *Ho C, Chen K, See L*. Selection of scleral buckling for primary retinal detachment. Ophthalmologica 2002; 216(1): 33−9.
4. *Wilkinson CP*. Retinal detachment surgery: management 25 years ago. Retina 2006; 26(6 Suppl): S26−7.
5. *Van Tricht V, Zivojnovic R, Zeyen T, Van der Auwera JC, Claes C*. Conventional retinal detachment surgery: technique, complications and results. Bull Soc Belge Ophtalmol 1998; 270: 39−43.
6. *Oshima Y*. Two-Year Follow-up Study Comparing Primary Vitrectomy with Scleral Buckling for Macula-off Rhegmatogenous Retinal Detachment. Jpn J Ophthalmol 2000; 44(5): 538−49.
7. *Doyle E, Herbert EN, Bunce C, Williamson TH, Laidlaw DA*. How effective is macula-off retinal detachment surgery. Might good outcome be predicted. Eye (Lond) 2007; 21(4): 534−40.
8. *Diederen RM, la Heij EC, Kessels AG, Goezinne F, Liem AT, Hendrikse F*. Scleral buckling surgery after macula-off retinal detachment: worse visual outcome after more than 6 days. Ophthalmology 2007; 114(4): 705−9.
9. *Blagojević M, Ilić R, Tomović J, Misita V*. The adaptation curves after retinal detachment surgery. Mod Probl Ophthalmol. 1979; 20: 307−13.
10. *Misita V, Blagojević M, Dragumilo R*. Physical exertion following successfully operated retinal detachment. Fortschr Ophthalmol 1986; 83(2): 227-9. (German)
11. *Ignjacev M, Kuljaca Z, Nikolić Lj*. Surgical treatment of the sequelae of proliferative diabetic retinopathy in the posterior segment of the eye. Srp Arh Celok Lek 1987; 115(5−6): 655−60. (Serbian)
12. *Wilkinson CP, Bradford RH*. Complications of draining subretinal fluid. Retina 1984; 4(1): 1−4.
13. *Pastor JC, Fernandez I, de la Rodriguez RE, Coco R, Sanabria-Ruiz CM, Sanchez-Chicharro D*, et al. Surgical outcomes for primary rhegmatogenous retinal detachments in phakic and pseudophakic patients: The Retina 1 Project-report 2. Br J Ophthalmol 2008; 92(3): 378−82.
14. *Falkner-Radler CI, Myung JS, Moussa S, Chan RV, Smretschnig E, Kiss S*, et al. Trends in primary retinal detachment surgery: Results of a Bicenter study. Retina 2011; 31(5): 928−36.
15. *Liu F, Meyer CH, Mennel S, Hoerle S, Kroll P*. Visual Recovery after Scleral Buckling Surgery in Macula-Off Rhegmatogenous Retinal Detachment. Ophthalmologica 2006; 220(3): 174−80.
16. *Afrashi F, Akkin C, Egrilmez S, Erakgun T, Mentes J*. Anatomic outcome of scleral buckling surgery in primary rhegmatogenous retinal detachment. Int Ophthalmol 2005; 26(3): 77−81.

17. *La Heij EC, Derhaag PF, Hendrikse F.* Results of scleral buckling operations in primary rhegmatogenous retinal detachment. Doc Ophthalmol 2000; 100(1): 17−25.
18. *Thelen U, Amler S, Osada N, Gerding H.* Success rates of retinal buckling surgery: Relationship to refractive error and lens status: results from a large German case series. Ophthalmology 2010; 117(4): 785−90.
19. *Heussen N, Hilgers R, Heimann H, Collins L, Grisanti S.* Scleral buckling versus primary vitrectomy in rhegmatogenous retinal detachment study (SPR study): multiple-event analysis of risk factors for reoperations. SPR Study report no. 4. Acta Ophthalmol 2011; 89(7): 622−8.
20. *Vukosavljevic M, Stojkovic R, Vicic D.* Retinal detachment in the pseudophakic eye. Vojnosanit Pregl 2001; 58(1): 11−5.
21. *Hassan TS, Sarrafizadeh R, Ruby AJ, Garretson BR, Kuczynski B, Williams GA.* The effect of duration of macular detachment on results after the scleral buckle repair of primary, macula-off retinal detachments. Ophthalmology 2002; 109(1): 146−52.
22. *Lecleire-Collet A, Muraine M, Menard J, Brasseur G.* Predictive visual outcome after macula-off retinal detachment surgery using optical coherence tomography. Retina 2005; 25(1): 44−53.
23. *Abouzeid H, Becker K, Holz FG, Wolfensberger TJ.* Submacular fluid after encircling buckle surgery for inferior macula-off retinal detachment in young patients. Acta Ophthalmol 2009; 87(1): 96−9.
24. *Benson SE, Schlottmann PG, Bunce C, Xing W, Charteris DG.* Optical coherence tomography analysis of the macula after scleral buckle surgery for retinal detachment. Ophthalmology 2007; 114(1): 108−12.
25. *Henrich PB, Priglinger S, Klaessen D, Kono-Kono J, Maier M, Schötzau A,* et al. Macula-off retinal detachment--a matter of time. Klin Monbl Augenheilkd 2009; 226(4): 289−93.
26. *Yang CH, Lin HY, Huang JS, Ho TC, Lin CP, Chen MS*, et al. Visual outcome in primary macula-off rhegmatogenous retinal detachment treated with scleral buckling. J Formos Med Assoc 2004; 103(3): 212−7.

Received on October 10, 2014.
Revised on August 25, 2015.
Accepted on August 26, 2015.
Online First July, 2016.