BMJ Open Ophthalmology

Comparison of the visual outcome between macula-on and macula-off rhegmatogenous retinal detachment based on the duration of macular detachment

Chang Sup Lee ,[1] Karl Shaver,[2] Samuel Huisok Yun,[1] Daniel Kim,[1] Sijin Wen,[3] Ghassan Ghorayeb[1]

To cite: Lee CS, Shaver K, Yun SH, *et al*. Comparison of the visual outcome between macula-on and macula-off rhegmatogenous retinal detachment based on the duration of macular detachment. *BMJ Open Ophthalmology* 2021;**6**:e000615. doi:10.1136/bmjophth-2020-000615

Received 17 September 2020
Revised 21 January 2021
Accepted 22 February 2021

[1]Ophthalmology, West Virginia University, Morgantown, West Virginia, USA
[2]Joan C Edwards School of Medicine at Marshall University, Huntington, West Virginia, USA
[3]Biostatistics, West Virginia University School of Public Health, Morgantown, West Virginia, USA

Correspondence to
Dr Ghassan Ghorayeb; 1975grg@gmail.com

ABSTRACT

Objective To compare the visual outcomes between macula-on and macula-off primary rhegmatogenous retinal detachment (RRD) based on the duration of macular detachment (DMD).

Methods and Analysis Retrospective study including 96 eyes with RRD (34 macula-on and 62 macula-off) repaired between June 2012 and March 2020. The final visual acuity (VA) was compared after the patients were divided by the status of the macula and their DMD.

Results The mean final VA of patients with macula-on RRD (group A) was logarithm of the minimum angle of resolution (logMAR) 0.04±0.07, which was not statistically different from that of individuals with macula-off RRD with DMD ≤3 days (group B; logMAR 0.05±0.06) (p=0.79). There were statistically significant differences in the final VA between group A and patients with macula-off RRD with DMD of 4–7 days (group C; logMAR 0.15±0.15) (p=0.017) as well as between group A and those with macula-off RRD with DMD ≥8 days (group D; logMAR 0.36±0.29) (p<0.001). There was no significant difference in the final VA between group B and C (p=0.33).

Conclusion The mean final VA of patients with macula-on RRD was comparable to that of the macula-off patients with DMD ≤3 days. Our findings suggest that if macula-on RRD could not be immediately repaired, a repair within 72 hours may result in similar outcomes, even if the macula detaches within that time frame. However, once the macula detaches, we do not observe statistically significant differences in outcome for repairs done within 7 days.

Key messages

What is already known about this subject?

- Although a 7-to-10-day window was previously considered standard practice for macula-off rhegmatogenous retinal detachment (RRD), there is growing evidence that earlier interventions within 72 hours may be associated with improved visual outcomes.

What are the new findings?

- We demonstrated that the mean final visual acuity of patients with macula-on RRD was not statistically different from that of individuals with macula-off RRD, whose duration of macular detachment (DMD) was ≤3 days. There were statistically significant differences in the final visual acuity between the patients with macula-on RRD and those with macula-off RRD with DMD of 4–7 days and DMD≥8 days.

How might these results change the focus of research or clinical practice?

- Earlier interventions may improve the visual outcomes in patients with macula-off RRD. Larger studies are warranted to confirm the effect of DMD on long-term visual outcomes.

INTRODUCTION

Rhegmatogenous retinal detachment (RRD) occurs when structural changes in the vitreous cause retinal tears and passage of a liquefied vitreous through the break, resulting in separation of the neurosensory layer of the retina from the retinal pigment epithelium.[1] Previous studies have reported that the involvement of the macula was a poor prognostic factor in RRD.[2–7] Several preoperative factors that affect the visual outcomes in macula-off RRD have been identified, including the patients' age, preoperative visual acuity (VA), the height of detachment and the duration of macular detachment (DMD).[3 8]

A 7-to-10-day window was considered standard practice for repairing macula-off RRD; however, patients included in these prior studies were primarily managed by scleral buckling (SB), and more recent evidence suggests that earlier interventions may be associated with better outcomes in macula-off RRD.[9–14] Yorston *et al* reported that better visual outcomes were observed in macula-off RRD repaired with vitrectomy when the

duration of foveal detachment was less than 3 days.[13] A recent study by Malosse *et al* described that outer retinal layer damage was more prevalent in spectral domain optical coherence tomography in patients with macula-off RRD with longer DMD.[15] In addition, previous studies on animal models revealed that the hypoxia induced by retinal detachment could cause molecular and cellular changes in the photoreceptors as early as 1–3 days.[16 17]

Reattachment of the macula does not guarantee significant improvements in vision. Some patients may experience metamorphopsia and dysmetropsia after the repair, especially when the fovea is involved.[6 18] Other factors, including cystic outer retinal degeneration, retinal folds, cystoid macular oedema, epiretinal membrane and proliferative vitreoretinopathy (PVR), have been found to impact the degree of vision improvement.[3 19–22]

This study aims to evaluate the effects of DMD on the final VA in macula-off RRD compared with the visual outcomes in macula-on RRD. We hypothesised that the visual outcomes in macula-off RRD would be closer to those of macula-on RRD if the macular attachment was achieved earlier. We also evaluated if phakic status, preoperative VA and the presence of PVR grade C or worse could help predict the postoperative outcomes.

PATIENTS/MATERIALS AND METHODS

This retrospective study included 96 eyes in 96 patients diagnosed and treated for primary RRD at a tertiary referral centre from June 2012 to March 2020. The approval of the West Virginia University Institutional Review Board was obtained. It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting or dissemination plans of our research. An initial search was conducted using the West Virginia Clinical and Translational Science Institute's Integrated Data Repository and ICD-10 diagnosis and procedure codes. We used strict exclusion criteria, and the list of exclusion criteria is summarised in table 1. Ninety-six eyes met the inclusion criteria, which were: RRD without other ophthalmic comorbidity, single operation success, follow-up of at least 1 month and known DMD.

RRD was categorised as either macula-on (macula-sparing) or macula-off (macula-involving). Thirty-four patients had macula-on RRD (macula-sparing), and 62 patients had macula-off RRD (macula-involving). Individuals with macula-on RRD were included in group A. We further divided patients with macula-off RRD into three groups based on their DMD: group B (DMD≤3 days; n=22), group C (DMD between 4–7 days; n=22) and group D (DMD≥8 days; n=18). In macula-off RRD cases, DMD was recorded as the number of days from the time of central vision loss to the time of intervention.

We recorded age, gender, phakic status, laterality, the presence of intraoperative PVR grade C or worse, types of procedures, preoperative best-corrected visual acuity (BCVA) and follow-up duration. Postoperative final BCVA was measured at the most recent visit. Snellen

Table 1 Exclusion criteria

Exclusion criteria	Number of patients
Retinal tear or hole without RD	173
Recurrent RD that required more than one surgery	100
Unclear time of onset of central vision loss	73
Other types of RD (tractional or exudative)	67
Trauma-related RD	47
Less than 1 month follow-up	46
Posterior vitreous detachment without RD	38
Other diseases (advanced AMD, BRVO, CRVO, dense ERM, dense vitreous haemorrhage, diabetic macular oedema, ischaemic optic neuropathy, subretinal haemorrhage, vitreomacular traction)	34
Treatment performed at outside hospitals	23
Lens pathology (dense cataract, posterior capsular opacity, dislocated IOL)	15
Retinoschisis	12
Endophthalmitis	8
Amblyopia	8
Non-communicative patients	8
End-stage glaucoma	7
Macular hole	7
Chronic RD greater than 6 weeks	6
Other congenital conditions (coloboma, Stickler syndrome, microphthalmia)	5
Corneal diseases (keratoconus, central corneal ulcer)	4
Choroidal detachment and haemorrhage	2
Posterior uveitis	2
Total	685

AMD, age-related macular degeneration; BRVO, branch retinal vein occlusion; CRVO, central retinal vein occlusion; ERM, epiretinal membrane; IOL, intraocular lens; RD, retinal detachment.

VA was converted into the logarithm of the minimum angle of resolution (logMAR) scale for statistical analysis. We assigned logMAR values of 2.0 and 2.3 to represent counting fingers and hand motion VA, respectively.[23] There were no patients who demonstrated VA worse or equal to light perception in our study.

Our patients underwent pars plana vitrectomy (PPV), SB or pneumatic retinopexy (PnR) and the types of procedures performed in each group are summarised in table 2. PPV was the primary procedure in 44 eyes without other interventions, while SB was performed in two eyes as the primary procedure. Combined PPV and SB were done in 10 eyes. Twenty-five eyes received PnR as the primary procedure without additional surgeries. We included 15 patients who received PnR prior to PPV (11 eyes), SB (2 eyes) and combined PPV and SB (2 eyes).

Table 2 Demographics data, phakic status, the preoperative and the final VA in the logMAR scale and the procedures performed in each group

	Total	Macula-on (group A)	Macula-off (group B+C+D)	Group B (DMD ≤3 days)	Group C (DMD 4–7 days)	Group D (DMD ≥8 days)
n	96	34	62	22	22	18
Age in years (mean±SD)	59.0±10.9	55.3±10.6	61.1±10.6	62.8±8.33	60.5±9.76	59.7±13.9
Male:female	63:33	20:14	43:19	17:5	15:7	11:7
Phakic patients (%)	49%	68%	42%	41%	41%	44%
Number of detached quadrants (mean±SD)	–	–	1.95±0.81 (n=57)	1.85±0.67 (n=20)	2.05±0.97 (n=21)	1.94±0.77 (n=16)
Preoperative VA in logMAR (mean±SD)	1.03±0.85	0.11±0.09	1.53±0.64	1.60±0.62	1.45±0.65	1.54±0.67
Final VA in logMAR (mean±SD)	0.13±0.19	0.04±0.07	0.175±0.22	0.05±0.06	0.15±0.15	0.36±0.29
PPV only (n)	44	13	31	10	12	9
SB only (n)	2	2	0	0	0	0
PPV + SB (n)	10	1	9	1	3	5
PnR only (n)	25	13	12	6	5	1
PnR + PPV (n)	11	3	8	5	2	1
PnR + SB (n)	2	2	0	0	0	0
PnR + PPV + SB (n)	2	0	2	0	0	2

The number of detached quadrants was noted for patients with macula-off RRD.
DMD, duration of macular detachment; logMAR, logarithm of the minimum angle of resolution; PnR, pneumatic retinopexy; PPV, pars plana vitrectomy; SB, scleral buckling; VA, visual acuity.

These cases were not classified as recurrent RRDs, because the retinal attachment was never successfully achieved with the initial PnR alone. In these cases, PPV and SB were performed immediately after the retinal attachment was found to be unsuccessful, and the mean duration between the PnR and PPV and SB was 3.6±3.0 days. The DMD was measured from the day of central vision loss to the day of PPV and SB.

The correlation between the preoperative VA and the final outcome of patients with RRD was assessed and compared between patients with preoperative VA, better or worse than Snellen VA 20/400. Wilcoxon rank-sum test was used in the analysis of continuous outcomes between two groups, and Fisher exact test was used in the analysis of categorical outcomes. Spearman's correlation was estimated between continuous variables. Analysis of variance (ANOVA) analysis was used to assess the differences of VA among three groups based on their DMD. A multivariable linear regression model was used to assess the final postoperative BCVA, when adjusted for age, gender, laterality, phakic status, the presence of PVR grade C or worse, preoperative BCVA, the number of detached quadrants and the types of interventions, including PPV, SB and PnR. A stepwise variable selection was carried out to identify the best subgroup of independent variables based on Akaike Information Criterion (AIC) statistics. All statistical tests were two-sided, and $p<0.05$ was considered statistically significant. Statistical analyses were carried out using SAS V.9.1 (SAS Institute, Cary, North Carolina, USA) and R software (V.3.6.3, R Foundation, Vienna, Austria).

RESULTS

Ninety-six eyes (49 left eyes) in 96 patients (63 men) were included in the study. The demographic data are summarised in table 2. The mean age was 59.0 years (SD=10.9 years). Forty-nine phakic patients and 47 pseudophakic patients were identified. The median DMD was 4 days (range: 1–21 days). The median follow-up duration was 15.8 months (range: 1 month to 7 years).

The demographic information (age, gender), phakic status, types of interventions and the preoperative and postoperative BCVA in each group are summarised in table 2. The mean number of detached quadrants in patients with macula-off RRD is recorded in table 2 as well. As judged by multiple linear models, no statistically significant differences in the mean final VA were found between group A (logMAR 0.04±0.07) and group B (logMAR 0.05±0.06) ($p=0.78$). However, there were significant differences in the final VA between group A and group C (logMAR 0.15±0.15) ($p=0.017$) and between group A and group D (logMAR 0.36±0.30) ($p<0.001$). When the final VA values of group B and C were compared, there were no statistically significant differences in mean final VA ($p=0.33$).

The mean final VA of patients with macula-off RRD was stratified by their DMD with a 1-day interval up to DMD of 10 days, and the results are summarised in table 3. The mean final VA was comparable among patients with the

Table 3 The final VA of patients with macula-off RRD stratified by their DMD with a 1 day interval up to DMD of 10 days

DMD in days	n	Mean final VA (logMAR)
1	7	0.04
2	4	0.08
3	11	0.05
4	7	0.12
5	7	0.21
6	1	0.30
7	7	0.08
8	4	0.23
9	4	0.22
10	4	0.37
11 or greater	7	0.48

DMD, duration of macular detachment; logMAR, logarithm of the minimum angle of resolution; RRD, rhegmatogenous retinal detachment; VA, visual acuity.

DMD of 1–3 days; however, there was a tendency of worsening final VA starting at DMD of 4 days.

A scatter-plot was used to illustrate the association between the DMD and the final VA in patients with macula-off RRD (figure 1). There was a positive correlation between them (Spearman correlation coefficient=0.60, p<0.0001), demonstrating that earlier interventions may be associated with overall better VA at the final visit.

In patients with macula-off RRD, there was a statistically significant difference in the final VA between patients with preoperative VA ≥20/400 and those with <20/400 using univariate analysis (p=0.042) (table 4). There was no significant association between phakic status and the final VA (p=0.62) (table 5). However, there were

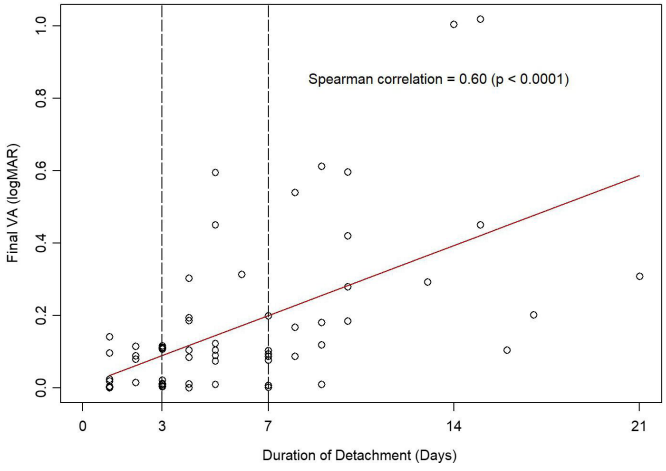

Figure 1 A scatter-plot of the duration of macular detachment vs the final VA in macula-off RRD (Spearman correlation coefficient=0.60, p<0.0001). logMAR, logarithm of the minimum angle of resolution; RRD, rhegmatogenous retinal detachment; VA, visual acuity.

Table 4 Comparison of the mean final VA based on the preoperative VA in patients with macula-off RRD (Wilcoxon rank-sum test).

Preop VA	n	Final VA in logMAR (mean±SD)	P value
≥20/400 (or ≤logMAR 1.3)	32	0.129±0.20	0.042
<20/400 (or >logMAR 1.3)	30	0.224±0.237	

logMAR, logarithm of the minimum angle of resolution; RRD, rhegmatogenous retinal detachment; VA, visual acuity.

statistically significant differences in the final VA when the patients were divided based on the presence of PVR grade C or worse (p=0.016) (table 6). In a multivariable linear regression model, DMD≥8 days significantly correlated with worse final VA (coefficient=0.132, SD=0.04, p=0.0005, AIC=2.12) in macula-off RRD, when adjusted for potential confounding variables including age, gender, laterality, phakic status, the presence of PVR grade C or worse, preoperative BCVA, the number of detached quadrants and the types of interventions, including PPV, SB and PnR. After a stepwise variable selection based on AIC statistic, the final model (AIC=1.86) included the phakic status (p=0.08), SB (p=0.012), PnR (p=0.08), preoperative BCVA (p=0.02) and the group of DMD (p<0.0001).

DISCUSSION

Our study aimed to determine the effect of the DMD on the visual outcomes in macula-off RRD. We hypothesised that earlier repair of the macular detachment in macula-off RRD would result in similar visual outcomes to those of macula-on RRD.

Burton *et al* reported that patients with a macular detachment less than 5 days had better visual outcomes, and approximately 1 line of vision was lost for 1 additional week until 27 days.[24] Ross and Kozy reported no statistically significant differences in anatomic or visual outcomes if the repair was performed within the first 7 days of macular detachment and suggested that nonemergent treatments may be more cost-effective.[11] Studies from Hassan *et al* and Diederen *et al* demonstrated that good postoperative outcomes could be obtained in patients treated within 10 days of macular detachment.[10 25] However, these previous studies only included

Table 5 Comparison of the mean final VA based on the phakic status in patients with macula-off RRD (Wilcoxon rank-sum test).

Phakic status	n	Final VA in logMAR (mean±SD)	P value
Phakic	26	0.16±0.20	0.62
Pseudophakic	36	0.18±0.24	

logMAR, logarithm of the minimum angle of resolution; RRD, rhegmatogenous retinal detachment; VA, visual acuity.

Table 6 Comparison of the mean final VA based on the presence of PVR grade C or worse in patients with macula-off RRD (Wilcoxon rank-sum test).

PVR grade C or worse	n	Final VA in logMAR (mean±SD)	P value
Yes	11	0.32±0.29	0.016
No	51	0.14±0.19	

logMAR, logarithm of the minimum angle of resolution; PVR, proliferative vitreoretinopathy; RRD, rhegmatogenous retinal detachment; VA, visual acuity.

patients who underwent SB and did not investigate the effect of repair within the first 3 days of macular detachment.

In contrast, Van Bussel published a meta-analysis that reported better visual outcomes in patients with DMD less than 3 days compared with those with DMD of 4–7 days.[26] Furthermore, Greven *et al* described that patients with DMD less than 3 days had better outcomes than those with DMD of 4–7 days, and they included patients who underwent PPV with or without SB to ensure that the macula was attached after the drainage of SRF.[12] Yorston *et al* performed a large database study involving 2074 eyes undergoing vitrectomy for macula-off RRD and reported that there was a higher probability of achieving postoperative VA of ≤0.30 logMAR when the repair was performed within 3 days of vision loss.[13]

Our results demonstrated no differences in preoperative VA among patients with macula-off RRD when grouped by the DMD (table 2). In fact, the patients with macula-off RRD whose DMD was less than 3 days had worse preoperative VA than those with longer DMD. Group A (macula-on) had the mean final VA of logMAR 0.04±0.07 (Snellen 20/22), which was comparable to the 12-month postoperative VA of logMAR 0.06±0.1 (Snellen 20/23) in patients with pseudophakic macula-on RRD as reported by Rezai *et al*.[27] Their 12-month postoperative VA in macula-off patients was logMAR 0.2±0.3 (Snellen 20/32), which was similar to the final VA value of logMAR 0.175±0.22 (Snellen 20/30) in our macula-off RRD group.

The mean final VA of group A (macula-on) and B (macula-off, DMD≤3 days) was not significantly different. This indicates that the final visual outcomes in macula-off RD were similar to that of macula-on RRD when the macular attachment was achieved within 3 days of central vision loss. In contrast, there were significant differences in the final VA between group A and group C (macula-off; DMD 4–7 days) and between group A and group D (macula-off; DMD≥8 days). Although there was a small difference in the mean final VA between group B (macula-off, DMD≤3 days) and C (macula-off, DMD 4–7 days), it did not reach statistical significance.

Williamson *et al* reported that patients with fovea-on RRD achieved significantly better visual outcomes than fovea-off RRD regardless of the duration of vision loss.[6] On the contrary, our results showed that the final VA in macula-off RRD might be similar to that of macula-on RRD if macular detachment repair was performed within 3 days of central vision loss. Furthermore, Williamson *et al* demonstrated that patients with a shorter duration of vision loss (less than 3 days) had significantly better visual outcomes than those with 4–6 days of vision loss. However, their definition of vision loss was different from that of our study. Our study attempted to specify the number of days of central vision loss based on the patients' history, while they did not differentiate the central and peripheral vision loss, which may have resulted in variation in the estimation of the DMD.

There were no differences in the final VA among patients with macula-off RRD with DMD of 1 day, 2 days or 3 days, while patients with DMD of 4 days or greater had worse final VA (table 3). This suggests that the visual outcomes might not differ up to DMD of 3 days, but it might be negatively affected by DMD starting on day 4. This supports Henrich's study, which demonstrated a statistically significant decrease in VA gain in patients whose DMD was ≥4 days.[28] However, our results were inconsistent with a previous paper reporting that patients with shorter DMD were associated with the better final visual outcome even among patients with less than 3 days of DMD.[12]

Preoperative VA and the presence of PVR grade C or worse have been proposed as statistically significant predictors for visual outcome. Based on our analysis, a better preoperative VA and the absence of PVR grade C or worse were identified as potential positive prognostic factors consistent with the previous studies.[3 6 11 12 29] However, the phakic status of our patients was not found to be a significant factor in predicting the visual outcomes in our study. This might be because 19 out of 26 patients (73%) who were initially labelled as phakic and had macula-off RRD later underwent cataract extraction before the final visit. Furthermore, we included patients with relatively short follow-up duration, which might be too early for post-PPV cataracts to develop. The mean duration of follow-up was 161±96 days in patients with macula-off RRD who were still phakic at the final visit.

Our study's limitations include the small sample size, the retrospective nature of the study, and the fact that we had to rely on elicited patients' history, which may not be accurate for estimating the exact DMD.[30] A randomised prospective study might minimise any bias, which could not be done due to ethical reasons.[9] We have excluded patients with trauma and those who had recurrent RRD; therefore, extrapolating the data to these patients may not be applicable. We also did not assess the presence of metamorphopsia or dysmetropsia, which could affect the quality of life of postoperative patients.

In conclusion, the mean final VA of patients with macula-on RRD was comparable to that of the macula-off patients with a DMD≤3 days. The clinical implication based on the data cautiously suggests that if macula-on RRD cannot be immediately repaired, a repair completed within 72 hours appears to carry comparable outcomes

despite macular detachment within that time frame. However, we did not observe any statistically significant differences in the final visual outcomes for repairs done within 7 days after macular detachment. Larger studies are warranted to further investigate the effect of DMD on the long-term VA outcome.

Acknowledgements The research of S.W. was supported in part by the NIH grant under Award Number 5U54GM104942-03. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Contributors CSL: conceptualisation, data acquisition, analysis and interpretation of data, original draft writing; KS: conceptualisation, data acquisition, draft revision; SY: conceptualisation, draft revision; DK: conceptualisation, draft revision; SW: methodology, analysis and interpretation of data, draft revision; GG: conceptualisation, analysis and interpretation of data, draft revision, supervision.

Funding The research of SW was supported in part by the NIH grant under Award Number 5U54GM104942-03. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository.

ORCID iD

Chang Sup Lee http://orcid.org/0000-0002-8288-8378

REFERENCES

1 Mitry D, Fleck BW, Wright AF, *et al*. Pathogenesis of rhegmatogenous retinal detachment: predisposing anatomy and cell biology. *Retina* 2010;30:1561–72.
2 Frings A, Markau N, Katz T, *et al*. Visual recovery after retinal detachment with macula-off: is surgery within the first 72 h better than after? *Br J Ophthalmol* 2016;100:1466–9.
3 Tani P, Robertson DM, Langworthy A. Prognosis for central vision and anatomic reattachment in rhegmatogenous retinal detachment with macula detached. *Am J Ophthalmol* 1981;92:611–20.
4 Salicone A, Smiddy WE, Venkatraman A, *et al*. Visual recovery after scleral buckling procedure for retinal detachment. *Ophthalmology* 2006;113:1734–42.
5 Hartz AJ, Burton TC, Gottlieb MS, *et al*. Outcome and cost analysis of scheduled versus emergency scleral buckling surgery. *Ophthalmology* 1992;99:1358–63.
6 Williamson TH, Shunmugam M, Rodrigues I, *et al*. Characteristics of rhegmatogenous retinal detachment and their relationship to visual outcome. *Eye* 2013;27:1063–9.
7 Martin B, Willshaw HE. Visual acuity following retinal detachment surgery. *Mod Probl Ophthalmol* 1979;20:324–9.
8 Abouzeid H, Wolfensberger TJ. Macular recovery after retinal detachment. *Acta Ophthalmol Scand* 2006;84:597–605.
9 Mahmoudi S, Almony A. Macula-sparing rhegmatogenous retinal detachment: is emergent surgery necessary? *J Ophthalmic Vis Res* 2016;11:100–7.
10 Hassan TS, Sarrafizadeh R, Ruby AJ, *et al*. The effect of duration of macular detachment on results after the scleral buckle repair of primary, macula-off retinal detachments. *Ophthalmology* 2002;109:146–52.
11 Ross WH, Kozy DW. Visual recovery in macula-off rhegmatogenous retinal detachments. *Ophthalmology* 1998;105:2149–53.
12 Greven MA, Leng T, Silva RA, *et al*. Reductions in final visual acuity occur even within the first 3 days after a macula-off retinal detachment. *Br J Ophthalmol* 2019;103:1503-1506.
13 Yorston D, Donachie PHJ, Laidlaw DA, *et al*. Factors affecting visual recovery after successful repair of macula-off retinal detachments: findings from a large prospective UK cohort study. *Eye* 2020. doi:10.1038/s41433-020-1021-y. [Epub ahead of print: 24 Jun 2020].
14 Grabowska A, Neffendorf JE, Yorston D, *et al*. Urgency of retinal detachment repair: is it time to re-think our priorities? *Eye* 2020. doi:10.1038/s41433-020-01154-w
15 Malosse L, Rousseau H, Baumann C, *et al*. Prevalence and risk factors for outer retinal layer damage after macula-off retinal detachment. *Br J Ophthalmol* 2020;104:660–5.
16 Lewis GP, Charteris DG, Sethi CS, *et al*. The ability of rapid retinal reattachment to stop or reverse the cellular and molecular events initiated by detachment. *Invest Ophthalmol Vis Sci* 2002;43:2412–20.
17 Linberg KA, Sakai T, Lewis GP, *et al*. Experimental retinal detachment in the cone-dominant ground squirrel retina: morphology and basic immunocytochemistry. *Vis Neurosci* 2002;19:603–19.
18 Ugarte M, Williamson TH. Horizontal and vertical micropsia following macula-off rhegmatogenous retinal-detachment surgical repair. *Graefes Arch Clin Exp Ophthalmol* 2006;244:1545–8.
19 Wolfensberger TJ, Gonvers M. Optical coherence tomography in the evaluation of incomplete visual acuity recovery after macula-off retinal detachments. *Graefes Arch Clin Exp Ophthalmol* 2002;240:85–9.
20 Reese AB. Defective central vision following successful operations for detachment of the Retina*. *Am J Ophthalmol* 1937;20:591–8.
21 Bonnet M, Bievelez B, Noel A, *et al*. Fluorescein angiography after retinal detachment microsurgery. *Graefes Arch Clin Exp Ophthalmol* 1983;221:35–40.
22 Charteris DG, Sethi CS, Lewis GP, *et al*. Proliferative vitreoretinopathy-developments in adjunctive treatment and retinal pathology. *Eye* 2002;16:369–74.
23 Lange C, Feltgen N, Junker B, *et al*. Resolving the clinical acuity categories "hand motion" and "counting fingers" using the Freiburg Visual Acuity Test (FrACT). *Graefes Arch Clin Exp Ophthalmol* 2009;247:137–42.
24 Burton TC. Recovery of visual acuity after retinal detachment involving the macula. *Trans Am Ophthalmol Soc* 1982;80:475–97.
25 Diederen RMH, La Heij EC, Kessels AGH, *et al*. Scleral buckling surgery after macula-off retinal detachment: worse visual outcome after more than 6 days. *Ophthalmology* 2007;114:705–9.
26 van Bussel EM, van der Valk R, Bijlsma WR, *et al*. Impact of duration of macula-off retinal detachment on visual outcome: a systematic review and meta-analysis of literature. *Retina* 2014;34:1917–25.
27 Rezar S, Sacu S, Blum R, *et al*. Macula-on versus macula-off pseudophakic rhegmatogenous retinal detachment following primary 23-gauge vitrectomy plus endotamponade. *Curr Eye Res* 2016;41:543–50.
28 Henrich PB, Priglinger S, Klaessen D, *et al*. Macula-off retinal detachment--a matter of time? *Klin Monbl Augenheilkd* 2009;226:289–93.
29 Yang C-H, Lin H-Y, Huang J-S, *et al*. Visual outcome in primary macula-off rhegmatogenous retinal detachment treated with scleral buckling. *J Formos Med Assoc* 2004;103:212–7.
30 Ng H, La Heij EC, van Meurs JC. The duration of macular detachment in retinal detachment is difficult to determine. *Acta Ophthalmol* 2020;98:e396–7.