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Influence of drainage retinotomy on anatomical and visual outcomes of pars plana vitrectomy for primary rhegmatogenous retinal detachment

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ABSTRACT

Objectives To assess the influence of drainage retinotomy (DrR) on anatomical and visual outcomes of pars plana vitrectomy (PPV) for primary uncomplicated rhegmatogenous retinal detachment (RD), compared with drainage through pre-existing retinal break (PRB).

Methods and analysis Retrospective study on patients treated with PPV for RD. Prospectively collected data were extracted from the Britain & Eire Association of Vitreoretinal Surgeons and European Society of Retina Specialists (EURETINA) RD database, including baseline features, surgical details, and anatomical and functional outcomes. Inclusion criteria were as follows: uncomplicated PPV, gas tamponade, drainage through DrR or PRB, surgeons with >100 cases recorded. Exclusion criteria were as follows: age <16, <2-month follow-up, ocular comorbidity, proliferative vitreoretinopathy ≥grade C, giant retinal tear, tamponade other than gas. Full propensity score matching resulted in matched groups to mitigate confounding bias. Subsequent multivariable linear regression was performed for postoperative best-corrected visual acuity (BCVA) as dependent variable, and Firth penalised logistic regression with DrR, single-surgery anatomical success (SSAS), epiretinal membrane (ERM) and macular fold as dependent dichotomised variables on matched data.

Results Of 12 504 eyes extracted, 4175 were included. Of these, 3432 (82.2%) had PRB drainage (non-DrR group) and 743 (17.8%) a DrR (DrR group). Final median (IQR) BCVA was 0.18 (0.14–0.48) in the non-DrR group and 0.20 (0.18–0.48) in the DrR group (p=0.072). SSAS rate was 93.4% and 91% (OR 0.71 (95% CI 0.54 to 0.95)) and postoperative ERM rate 1.6% and 4.2% (OR 2.63 (95% CI 1.68 to 4.10)) in the non-DrR and DrR groups, respectively. On multivariable regression, DrR was associated with postoperative ERM (p=0.011), but not with final BCVA, SSAS and macular folds (p=0.633, 0.149 and 0.085, respectively).

Conclusion Our study confirmed the association between DrR and increased risk of developing ERM; however, DrR does not appear to impact significantly on other outcomes.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Drainage retinotomy (DrR) is a surgical manoeuvre to increase the drainage of subretinal fluid during pars plana vitrectomy.
⇒ DrR has been reported as an independent risk factor for the development of epiretinal membrane after retinal detachment repair.

WHAT THIS STUDY ADDS

⇒ DrR does not have any significant impact on single-surgery success rate after primary rhegmatogenous retinal detachment repair.
⇒ DrR does not influence final best-corrected visual acuity after primary rhegmatogenous retinal detachment repair.
⇒ DrR does not appear to influence the rate of postoperative macular fold formation.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ In surgical practice, the need for a DrR should be carefully considered and performed only if necessary.
⇒ We found no evidence that DrR improves the anatomical or functional outcomes of surgery for low-complexity retinal detachment, and surgeons should be reassured that it is not essential to perform a retinotomy.

INTRODUCTION

Pars plana vitrectomy (PPV) is the most commonly performed surgical procedure for rhegmatogenous retinal detachment (RRD) repair.[1 2] The risk factors affecting surgical failure as well as functional outcomes of retinal detachment (RD) repair are mainly related to baseline findings, such as age, gender, lens status, preoperative visual acuity (VA), ocular copathologies, grade of proliferative vitreoretinopathy (PVR), location of retinal breaks and inferior RD extent.[3 4] However, it has also been shown that intraoperative variables, such as choice of tamponade, can affect the results of the surgical procedure.[3 5 6]

Drainage retinotomy (DrR) is a surgical step aimed to facilitate and optimise the drainage of subretinal fluid (SRF) during PPV and is traditionally considered beneficial in terms of reduced risk of retinal folds formation.[7 8] According to a recent survey conducted by the American Society of Retina Specialists, a posterior DrR was used to drain SRF by 38% of American respondents versus 10% of international respondents. Drainage through a pre-existing peripheral retinal break was the preferred drainage technique in both groups.[9] Although the potential complications associated with this manoeuvre have long been known (eg, PVR at the retinotomy site),[10] some recent retrospective studies have noted the potential influence of DrR on the anatomical outcomes of PPV for rhegmatogenous RD, when compared with alternative drainage techniques.[11–15] In particular, DrR has been reported as an independent risk factor for epiretinal membrane (ERM) formation after PPV for RD[11 13 14] and surgical failure.[13] However, these studies have been based on small samples,[12–14] except for one registry-based retrospective analysis of 2239 eyes.[11] Large databases, with a greater sample size including data from multiple surgeons and centres, have the potential to overcome some of the more common limitations of small-sized and single-centre studies, and also allow for a more accurate risk factor analysis.[11]

The aim of this study was to assess the effect of DrR on anatomical and visual outcomes of PPV in primary rhegmatogenous RD repair when compared with drainage through a pre-existing retinal break in a large cohort of patients.

METHODS AND ANALYSIS

Data from the Britain & Eire Association of Vitreoretinal Surgeons and European Society of Retina Specialists (EURETINA) RD database were extracted in February 2023, including all eyes that were treated with PPV due to uncomplicated primary rhegmatogenous RD from March 2011 to February 2022. The database conforms to the UK national RD dataset (https://www.rcophth.ac.uk/standardspublications-research/audit-and-data/clinical-data-sets/retinal-detachment-data-set/) and has been described in previous publications.[2–4] No patient identifiable information is collected.

We included both phakic and pseudophakic uncomplicated primary rhegmatogenous RD. Eyes presenting with the following findings were excluded from analysis: any drainage other than DrR or drainage through a retinal break; any break type other than hole/horseshoe tear; an incomplete retinal drawing; 20G vitrectomy; any tamponade other than gas; any lens status other than phakic or pseudophakic with posterior chamber intraocular lens in the bag; giant retinal tears, PVR C or worse;[16] presence of subretinal bands; schisis-RD, macular hole-RD; age under 16; endophthalmitis (associated with RD or postoperatively); prior significant trauma; concomitant suprachoroidal haemorrhage; presence of choroidal detachments; previous vitrectomy; follow-up (FU) less than 2 months and significant ocular comorbidities (including age-related macular degeneration, amblyopic eyes, diabetic retinopathy, retinal vein occlusions and advanced glaucoma). We additionally excluded cases performed by surgeons that contributed <100 cases to reduce selection bias.

The following data were collected:

1. Baseline findings and presenting ocular characteristics: age, sex, laterality, ocular comorbidities, preoperative best-corrected visual acuity (BCVA), duration of vision loss (patient-reported), presence of posterior vitreous detachment, grade of concomitant vitreous haemorrhage,[17] foveal status (on or off), number of breaks in detached and attached retina, extent of largest retinal break (1 clock hour or bigger), location of the lowest retinal break on detached retina, RD extent in clock hours.
2. Intraoperative characteristics: vitrectomy gauge, combined cataract surgery, drainage technique (through the break or DrR), type of retinopexy (cryotherapy or endolaser), gas tamponade (short-acting or long-acting gas)
3. Postoperative outcomes: single-surgery anatomical success (SSAS), postoperative BCVA, VA gain, presence of ERM or macular fold.

As previously described,[2 18 19] different groups were derived on the basis of the RD distribution; in particular, we considered RD limited to a superior or inferior involvement (with respect to the midline). With regard to break location, we classified as 'superior' retinal breaks above the midline, including those located at 3 and 9 o'clock, and as 'inferior' retinal breaks below and including 4 and 8 o'clock. In our regression model, we used a continuous variable for lowest break location (representing increasing value from 12 o'clock to 6 o'clock).[1–7]

SSAS was defined as complete retinal reattachment without any tamponade agent present and/or any additional surgery for RD repair.

Statistical analysis

Statistical significance was defined as $p<0.05$. Prior to analysis, continuous variables were assessed using the Shapiro-Wilk test; hence, median (IQR) is primarily reported for continuous variables where data were not normally distributed. For univariable comparisons, the independent t-test was used to compare two categories for independent variables as it remains robust in large data even if the data are skewed.[20] The Fisher exact and χ^2 tests were used for independent nominal variables. The statistical analysis was completed with IBM SPSS Statistics software (V.29.0.1; Armonk, New York: IBM Corp) and R V.4.3.2 (The R Foundation, Vienna, Austria).

The conversion of non-numeric VA values to logMAR was performed as follows: count fingers equivalent to 1.98, hand movements to 2.28, perception of light to 2.70, and no perception of light equivalent to 3.00.[21]

We first compared the DrR group with the non-DrR groups after exclusions to assess phenotypic features that made surgeons more likely to use a DrR. We subsequently performed full propensity score matching to make the two groups comparable for prognostically significant covariates to mitigate confounding bias in the effect estimate. We matched on the age and sex, baseline VA, high myopia, foveal attachment, extent and position of breaks, the extent, lens status, combined phacovitrectomy and PVR B. We formed full matching using the MatchIt library in R.[22] We confirmed satisfactory covariate balance in our matched samples by visualising standardised mean differences (SMDs). Full matching was used to minimise bias more effectively than nearest neighbour matching, especially with unbalanced groups, by retaining all units in the analysis and optimising covariate balance. On matched data, SMDs are provided instead of significance tests with a tolerance of |SMD| <0.10 indicating adequate balance.

Following this, we conducted multivariable linear regression on matched data for postoperative BCVA as the dependent variable, and Firth penalised logistic regression with the following dependent dichotomised variables: DrR, SSAS, postoperative ERM and macular fold. All multivariable models were risk adjusted for baseline BCVA by adding this as a covariate. In addition to our matching covariates, for the remaining regression models, we added the following factors: long-acting gas tamponade (relative to short) and post-operative lens status.

RESULTS

Data of 14 006 eyes treated with RD were extracted. After applying the above-mentioned exclusion criteria, a total of 4175 eyes were included in the analysis, of which 3432 (82.2%) had drainage through pre-existing retinal break (non-DrR group) and 743 (17.8%) through a DrR (DrR group). There were 23 contributing surgeons that contributed ≥100 cases each with a median of 196 (135–283) cases. Preoperative BCVA was available for 3978 (95.3%), 3262 (95.0%) and 716 (96.4%) for all cases, non-DrR group and DrR group, respectively. Both preoperative and postoperative BCVA were available for 3753 (89.9%), 3076 (89.6%) and 677 (91.1%) for all cases, non-DrR group and DrR group, respectively. Baseline findings, surgical details and outcomes are shown in table 1, along with the results of the comparison between the non-DrR group and the DrR group on univariable analysis.

Means and percentages are weighted by the full-matching weights so that the matched treated and control groups reflect the covariate balance used in subsequent outcome models. We verified the covariate balance assessment through absolute SMD Love plot (online supplemental figure 1).

Matched dataset

Our matched cases included all eyes that did not contain missing data for full propensity score matching(PSM) matching, 3230 in the non-DrR group and 712 in the DrR group. We have an effective sample size of 914.77 in the non-DrR group and retain the full 712 in the DrR group. This takes into account that some observations contribute more weight than others in the matched sample. Baseline characteristics of the full-matched cohort are shown in table 2.

Association of baseline RD findings with performing a drainage retinotomy

On univariable analysis, macular detachment, greater RD extent, total RD, greater number of retinal breaks, round hole-RD and inferior retinal breaks were associated with greater likelihood of performing a DrR (table 1). On multivariable logistic regression, greater RD extent and high myopia were associated with greater likelihood of performing a DrR, along with preoperative pseudophakia (figure 1A). In addition, the analysis of the proportion of DrR performed by user showed large inter-surgeon variability, with the percentage of DrR ranging from 0.2% to 61.1% (figure 1B).

Impact of drainage retinotomy on anatomical outcome

Median FU duration was 79 (IQR: 60 to 115) days in the non-DrR group and 79 (IQR: 63 to 113) in the DrR group (p=0.918).

Single-surgery success rate was 93.4% in the non-DrR group and 91.3% in the DrR group. Although the difference was statistically significant on univariable analysis (p=0.022), this finding was not confirmed on Firth logistic regression (p=0.149) (figure 2A).

Postoperative ERM rate was significantly higher in the DrR group, at 3.3%, compared with the non-DrR group (1.9%) (p=0.005). Firth logistic regression confirmed the significant association between DrR and postoperative development of ERM (p=0.011) (figure 2B). Additional risk factors for ERM development were large retinal breaks (>1 clock hour) and postoperative pseudophakia (figure 2B).

Finally, no association was found between DrR and postoperative macular folds (p=0.085), which showed an incidence of 0.4% and 0.5% in the non-DrR group and DrR group, respectively (table 1) (figure 2C).

Impact of drainage retinotomy on visual outcome

Overall median BCVA significantly improved from 0.60 (0.18–1.98) preoperatively to 0.18 (0.14–0.48) at the last FU (p<0.001, paired t-test). Despite preoperative BCVA being significantly worse in the DrR group (p=0.003), final median BCVA did not significantly differ postoperatively between the groups, being 0.18 (0.12–0.48) in the non-DrR group (3203 eyes) and 0.20 (0.18–0.48) in the DrR group (698 eyes) (p=0.072) (table 1, figure 3A). Overall, the median VA improvement was 0.30 (0.00–1.50) in non-DrR group and 0.44 (0.00–1.50) logMAR units in DrR group (p=0.009) (table 1, figure 3A).

Subgroup analysis of fovea sparing and involving RD

In the subgroup of eyes presenting with foveal sparing RD, final median BCVA as well as the VA gain did not significantly differ postoperatively, the former being 0.30 (0.18 to 0.60) and the latter 0.00 (−0.12 to 0.18) in both groups (p=0.368 and p=0.174, respectively) (table 1). However, in fovea involving subgroup, the median VA

Table 1 Baseline clinical, operative characteristics and outcomes before matching

	Total (4175)	Group A, drainage through break (3432)	Group B, drainage retinotomy (743)	P value* Group A versus B
Baseline characteristics				
Age (years)	61 (55–68)	61 (55–68)	61 (54–70)	0.426
Sex, male (n, %)	2642 (63.3%)	2158 (62.9%)	484 (65.1%)	0.257
Laterality (n, % right)	2231 (53.4%)	1818 (53.0%)	413 (55.6%)	0.209
Presenting VA				
All cases, logMAR	0.60 (0.18–1.98)	0.48 (0.18–1.98)	0.78 (0.18–1.98)	**0.003**, n=3978
Foveal attachment. logMAR	0.18 (0.00–0.30)	0.18 (0.00–0.30)	0.18 (0.00–0.22)	0.066, n=1933
Foveal detachment present, logMAR	1.98 (1.00–2.28)	1.98 (1.00–2.28)	1.98 (0.78–2.28)	**<0.001**, n=2045
Preop lens status				
Phakic	2996 (71.8%)	2539 (74.0%)	457 (61.5%)	**<0.001**
Pseudophakic-PCIOL	1179 (28.2%)	893 (26.0%)	286 (38.5%)	
Duration of vision loss in fovea involving cases (days)	4 (2–7)	4 (2–7)	4 (2–8)	0.599, n=1690
Duration of vision loss ≤3 days in foveal involving cases	701 (41.5%)	547 (42.2%)	154 (39.1%)	0.293, n=1690
High Myopia (>6 dioptres)	520 (12.5%)	460 (13.4%)	60 (8.1%)	**<0.001**
Any vitreous haemorrhage present (n, %)	792 (22.9%)	701 (24.1%)	91 (16.7%)	**<0.001**, n=3457
Extent RRD				
Total RD	125 (3.0%)	94 (2.7%)	31 (4.2%)	**0.043**
Clock hours detached	4 (4–6)	4 (3–6)	6 (4–8)	**<0.001**
Foveal attachment (n, %)				
Off	2125 (51.0%)	1647 (48.1%)	478 (64.4%)	**<0.001**
On	2044 (49.0%)	1780 (51.9%)	264 (35.6%)	
Any superior RD (n, %)	3913 (93.7%)	3204 (93.4%)	709 (95.4%)	**0.037**
Any inferior RD (n, %)	2771 (66.4%)	2162 (63.0%)	609 (82.0%)	**<0.001**
Isolated superior RD (n, %)	1402 (33.6%)	1268 (36.9%)	134 (18.0%)	**<0.001**
Isolated inferior RD (n, %)	260 (6.2%)	226 (6.6%)	34 (4.6%)	**0.044**
Largest break size >1 clock hour (n, %)	66 (1.6%)	60 (1.7%)	6 (0.8%)	0.073
Number of retinal breaks in detached retina	2 (1–3)	2 (1–3)	2 (1–3)	**<0.001**
Number of retinal breaks in attached retina	0 (0–1)	0 (0–1)	0 (0–0)	**0.020**
Largest break type				
U tear	3969 (95.1%)	3290 (95.9%)	679 (91.4%)	**<0.001**
Round hole	206 (4.9%)	142 (4.1%)	64 (8.6%)	
Break location				
Above 4 and 8 o'clock	3216 (77.6%)	2683 (78.7%)	533 (72.1%)	**<0.001**
Below 4–8 o'clock	930 (22.4%)	724 (21.3%)	206 (27.9%)	
PVR B present	339 (8.1%)	305 (8.9%)	34 (4.6%)	**<0.001**
Surgical characteristics				
Tamponade duration				
Short (SF6, Air)	2270 (54.4%)	1932 (56.3%)	338 (45.5%)	**<0.001**
Long (C3F8, C2F6)	1905 (45.6%)	1500 (43.7%)	405 (54.5%)	

Continued

Table 1 Continued

	Total (4175)	Group A, drainage through break (3432)	Group B, drainage retinotomy (743)	P value* Group A versus B
Retinopexy				
Cryotherapy	3367 (80.6%)	2673 (77.9%)	694 (93.4%)	**<0.001**
Endolaser	1729 (41.4%)	1219 (35.5%)	510 (68.6%)	**<0.001**
Combined cataract surgery	149 (3.6%)	125 (3.6%)	24 (3.2%)	0.663
Outcomes				
Postoperative VA				
All cases, logMAR	0.18 (0.14–0.48)	0.18 (0.14–0.48)	0.20 (0.18–0.48)	0.072, n=3901
Foveal attachment. logMAR	0.18 (0.00–0.30)	0.18 (0.00–0.30)	0.18 (0.00–0.30)	0.624, n=1776
Foveal detachment present, logMAR	0.30 (0.18–0.60)	0.30 (0.18–0.60)	0.30 (0.18–0.60)	0.368, n=2125
LogMAR gain				
All cases, logMAR	0.30 (0.00 to 1.50)	0.30 (0.00 to 1.50)	0.44 (0.00 to 1.50)	**0.009**, n=3753
Foveal attachment. logMAR	0.00 (–0.12 to 0.18)	0.00 (–0.12 to 0.18)	0.00 (–0.12 to 0.18)	0.174, n=1628
Foveal detachment present, logMAR	1.38 (0.52 to 1.80)	1.42 (0.58 to 1.80)	1.20 (0.42 to 1.80)	**0.004**, n=2125
SSAS	3882 (93.0%)	3206 (93.4%)	676 (91.0%)	**0.022**
ERM formation	87 (2.1%)	56 (1.6%)	31 (4.2%)	**<0.001**
Macular fold formation	17 (0.4%)	13 (0.4%)	4 (0.5%)	0.525

Statistical significance (p<0.05) in bold.
*n=4175, unless specified otherwise.
ERM, epiretinal membrane; PCIOL, posterior chamber intraocular lens; PVR, proliferative vitreoretinopathy; RD, retinal detachment; RRD, rhegmatogenous retinal detachment; SSAS, single-surgery anatomical success; VA, visual acuity.

improvement was 1.42 (0.58–1.80) in the non-DrR group and 1.20 (0.42–1.80) logMAR units in the DrR group (p=0.004) (table 1, figure 3B).

Multivariable linear regression confirmed no difference in final BCVA comparing the non-DrR group and the DrR group (p=0.633) (table 3) and, thus, no significant impact of DrR on final visual outcome. Factors significantly associated with worse final BCVA were baseline BCVA, age, male sex and RD features at presentation, including greater number of retinal breaks on detached retina, a break greater than 1 clock hour, isolated inferior RD, greater RD extent, macula involvement and PVR grade B (table 3). Conversely, pseudophakia (either at the baseline or postoperatively) was significantly associated with better visual outcomes (table 3).

DISCUSSION

We present the largest study to date assessing the potential impact of DrR on outcomes of primary RD repair, focusing on final BCVA, SSAS, ERM development and macular fold formation. In this regard, our study included more than three times the number of eyes of a recent systematic review and meta-analysis focused on the efficacy of DrR.[23] Indeed, although this manoeuvre appears to be commonly performed,[9 13] only a few, mainly small-sized, studies have evaluated its influence on surgical outcomes, leading to conflicting results in literature.[11–15 23 24] Moreover, DrR remains an invasive iatrogenic manoeuvre requiring an additional retinal hole in detached retina.[11] Understanding the advantages and disadvantages of DrR is essential for surgeons to make an evidence-based decision prior to performing DrR.

There are no established absolute indications to perform a DrR. In general, they are created if drainage of SRF through a peripheral retinal break is not feasible due to difficult access.[25] In our study, DrR was performed in 17.8%, consistent with the rate reported in the literature that varies from 10% to 41%.[11–15] In addition, DrR has been reported as being more commonly performed in cases with a worse prognosis, such as inferior retinal breaks, greater RD extent, macula involvement, higher PVR grade, worse VA and/or when silicone oil (SO) tamponade is used.[11 13 15] Although we only included uncomplicated primary rhegmatogenous RDs, this tendency towards performing DrR in more complex cases was confirmed by the association between DrR

Table 2 Baseline characteristics of the full-matched cohort

Stratified by drainage retinotomy	No	Yes	SMD
n	3230	712	
Age (years)	62.1 (10.7)	61.9 (11.0)	0.019
Sex (male)	1152.4 (35.7)	250.0 (35.1)	0.012
Baseline VA	1.12 (0.91)	1.07 (0.91)	0.062
High myopia	238.5 (7.4)	59.0 (8.3)	0.034
Fovea attached	1067.2 (33.0)	252.0 (35.4)	0.050
RD extent (hours)	6.2 (2.7)	6.2 (2.6)	0.002
Isolated superior RD	575.9 (17.8)	129.0 (18.1)	0.008
Isolated inferior RD	118.8 (3.7)	31.0 (4.4)	0.034
PVR grade B	154.4 (4.8)	33.0 (4.6)	0.007
Detached breaks	2.5 (1.7)	2.5 (1.8)	0.002
U-tears	2937.4 (90.9)	652.0 (91.6)	0.022
Break >1 clock hour size	34.5 (1.1)	6.0 (0.8)	0.023
Lowest break location	3.5 (1.7)	3.5 (1.7)	0.008
Pseudophakic RRD	1228.4 (38.0)	275.0 (38.6)	0.012
Combined phacovitrectomy	133.2 (4.1)	24.0 (3.4)	0.040

PVR, proliferative vitreoretinopathy; RD, retinal detachment; RRD, rhegmatogenous retinal detachment; SMD, standardised mean differences; VA, visual acuity.

and isolated inferior RD, greater RD extent, macular detachment and round hole-RD. Furthermore, to reduce selection bias and have a better representation of continuous surgical outcomes from independent surgeons, we only included surgeons that had contributed ≥100 cases to the database. Analysis of DrR rate per user showed extensive intersurgeon variability, suggesting that the decision to perform this manoeuvre was strongly influenced by surgeon preference. We believe this is representative of real-world surgical practice where the decision-making process can be strongly influenced by personal preferences.

Consistent with previous studies analysing the outcomes of primary uncomplicated rhegmatogenous RD,[13 26–28] our overall SSAS was 93%. Multivariable linear regression showed that DrR did not significantly impact primary retinal attachment, which was 93.4% in the non-DrR group and 91% in the DrR group (p=0.149). In contrast with our results, a recent retrospective study on 519 eyes identified DrR as a significant risk factor for surgical failure using both multivariate and a propensity score-matching analysis.[13] The authors hypothesised that this might be caused by two factors: first, increased intraocular inflammation and migration of inflammatory and retinal pigment epithelium (RPE) cells due to the creation of an intentional additional break along with the subsequent additional laser retinopexy; and second, more severe RD findings in the DrR group.[13] It is worth noting that the same study did not find a significant association between established negative prognostic factors (eg, greater RD extent and macular detachment) and surgical failure.[13] This might be due to the limited sample size resulting in the underestimation of the impact of baseline RD characteristics and highlighting the importance of working with large databases that include a wide range of baseline and surgical variables. In our study, initial univariable analysis showed an association between DrR and lower SSAS rate. However, multivariate logistic regression showed there was no increased risk of failure with DrR.

Traditionally, the reduced risk of postoperative retinal folds has been considered an important advantage of DrR due to optimisation of SRF drainage.[7 8] This aspect may be of particular relevance in foveal splitting RD because a macular fold along the line of detachment would severely impact functional outcomes.[7 8] We therefore compared

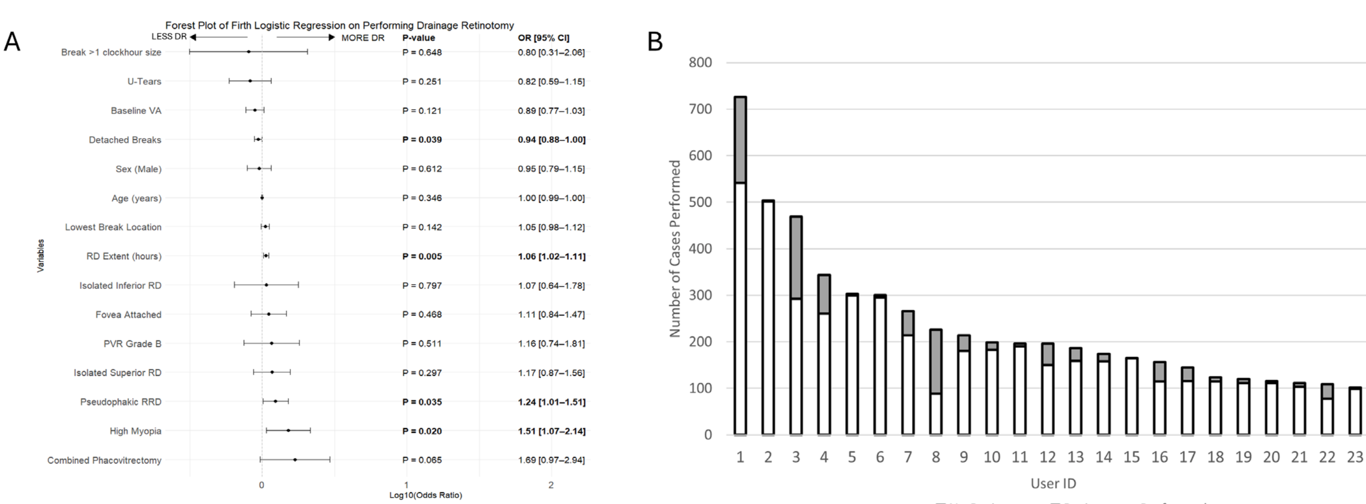

Figure 1 (A) Multivariable Firth logistic regression model found that greater RD extent, macular detachment, round hole-RD (U-tear reference) and pseudophakic RD were significantly associated with greater likelihood of performing a DrR. Worse preoperative BCVA, PVR B and isolated superior RD were significantly associated with less DrR. (B) Bar chart to demonstrate proportion of DrR performed by user. Significant values in bold. BCVA, best-corrected visual acuity; DrR, drainage retinotomy; PVR, proliferative vitreoretinopathy; RD, retinal detachment; VA, visual acuity; RRD, rhegmatogenous retinal detachment.

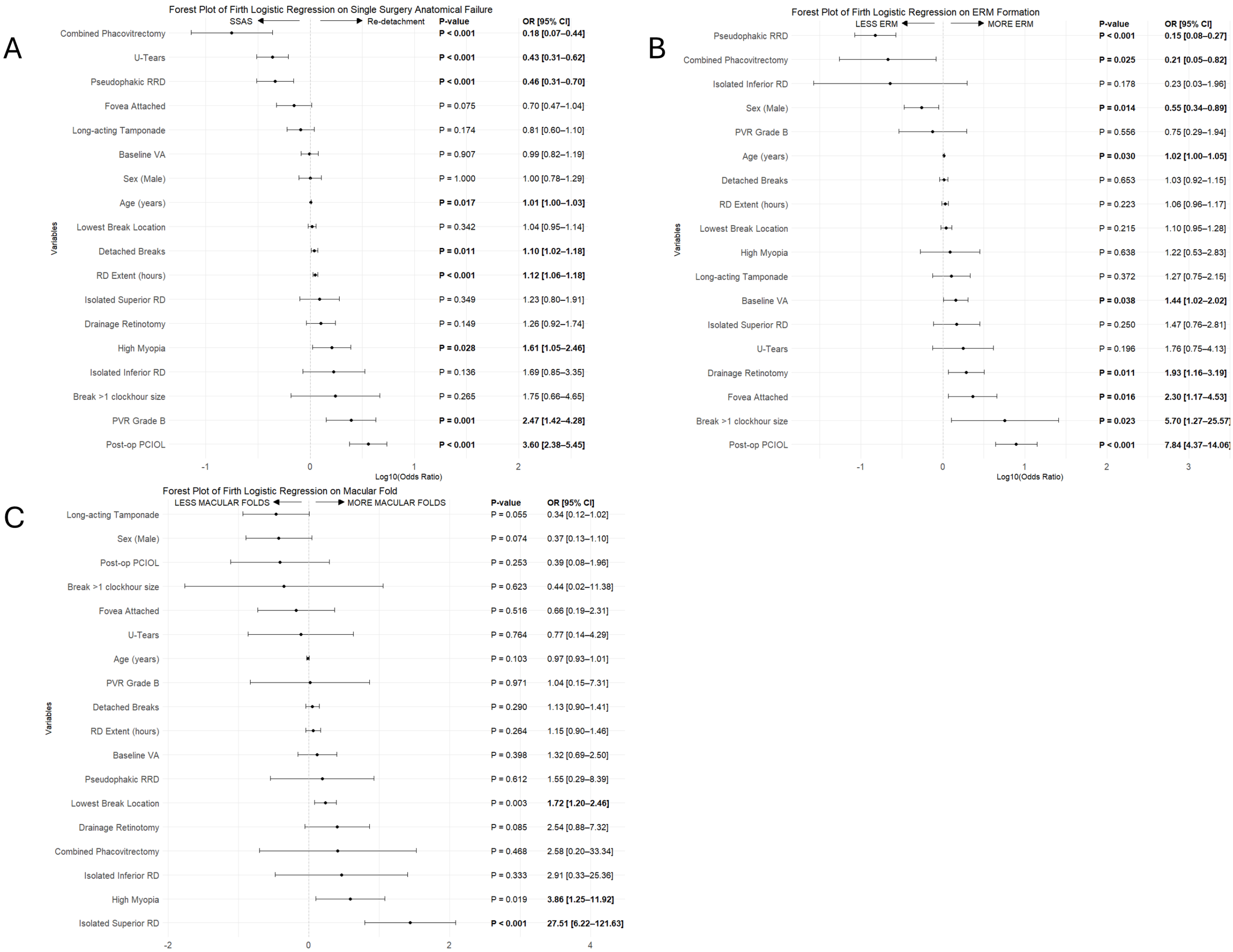

Figure 2 Multivariable Firth penalised logistic regression regarding risk of (A) redetachment: identified that combined phacovitrectomy and pseudophakic RD lead to reduced retinal redetachment. Increased extent of RD, more inferior retinal breaks, high myopia and being pseudophakic post-op were significant risk factors for redetachment; (B) ERM formation: demonstrated pseudophakic RD and high myopia lead to less ERM formation, while DrR, increased break size and postoperative pseudophakia lead to increased ERM; (C) macular fold formation: short-acting gas tamponade, female sex, more inferior breaks and isolated superior RD were associated with increased risk of macular folds. Significant values in bold. ERM, epiretinal membrane; PCIOL, posterior chamber intraocular lens; PVR, proliferative vitreoretinopathy; RD, retinal detachment; RRD, rhegmatogenous retinal detachment; SSAS, single-surgery anatomical success; VA, visual acuity.

macular fold formation between the DrR and non-DrR groups. However, our results did not support any benefit of DrR on reduced macular fold formation with a similar rate in both groups (0.4% and 0.5% in the non-DrR group and DrR groups, respectively). We could not compare our results with any existing literature because of the lack of data on the incidence of this adverse event, likely due to its rarity. A recent post hoc analysis of the PostRD randomised controlled trial[28] found that DrR was associated with lower amplitude of retinal displacement in macula-off RD (unpublished data); however, our study did not investigate retinal displacement. The PostRD study has previously shown that greater amplitude of retinal displacement is associated with worse visual outcomes.

Stronger evidence appears to support the role of DrR as a significant independent risk factor for the development of ERM after RD repair.[11 13 23] Epiretinal membrane is an established complication of RD surgery with a reported incidence varying from 5 to 50%.[11 13 29–31] In addition to DrR, several risk factors for postoperative ERM have been reported, including preoperative and intraoperative findings, such as macula off status, vitreous haemorrhage, choroidal detachment, cryotherapy, 360° laser retinopexy, >1000 laser shots and no internal limiting membrane (ILM) peeling.[30–32] Our study confirmed the significant association between DrR and postoperative ERM rate, accounting for 1.6% in the non-DrR group and 4.2% in the DrR group (p=0.028 on multivariable Firth penalised logistic regression). The increased risk of ERM formation

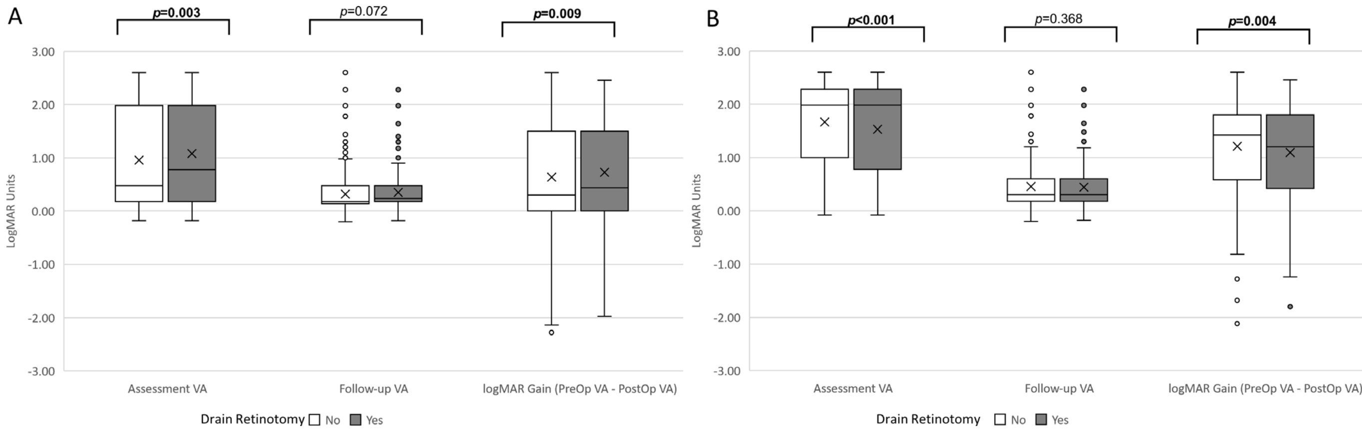

Figure 3 Box and whisker plot comparing BCVA between no DrR and DrR. On univariable analysis: (A) across the whole cohort, the DrR group had significantly worse preoperative BCVA, increased logMAR gain and no difference in FU BCVA. (B) In subgroup of foveal-detached eyes, the DrR group had significantly better preoperative BCVA, reduced logMAR gain and no difference in FU BCVA. Significant values in bold. BCVA, best-corrected visual acuity; DrR, drainage retinotomy; FU, follow-up; VA, visual acuity.

may be related to the glial cell activation induced by the intentional iatrogenic retinal hole (DrR) and the subsequent migration of inflammatory and RPE cells.[11 13] Due to the association between DrR and postoperative ERM, Ishikawa *et al*[11] suggested that ILM peeling may be considered when performing DrR. However, it has to be also considered that only a minority of post-RD ERM may be visually significant,[32] and the benefits of ILM peeling in preventing ERM should be weighed against the potential of iatrogenic mechanical damage to the retina during ILM peeling, at times on a detached macula.[33–35] To avoid potential confounding factors, we removed patients that underwent ILM peeling from the analysis.

Table 3 Multivariable linear regression model for follow-up visual acuity

Independent variable	B coefficient (95% CI)	P value
>1 clock hour break size	**0.263 (0.154 to 0.372)**	**<0.001**
Assessment VA	**0.139 (0.121 to 0.158)**	**<0.001**
PVR B	**0.111 (0.057 to 0.165)**	**<0.001**
Isolated inferior RD	**0.071 (0.006 to 0.137)**	**0.033**
Long-acting gas tamponade	**0.037 (0.008 to 0.065)**	**0.012**
Male	**0.026 (0.002 to 0.049)**	**0.033**
Number breaks in detachment	**0.023 (0.015 to 0.030)**	**<0.001**
Clock hours detached	**0.018 (0.012 to 0.023)**	**<0.001**
Drainage retinotomy	0.008 (–0.024 to 0.040)	0.633
Age	**0.003 (0.002 to 0.004)**	**<0.001**
Combined phacovitrectomy	–0.004 (–0.076 to 0.068)	0.912
Lowest break position	–0.005 (–0.014 to 0.004)	0.283
Isolated superior RD	–0.007 (–0.043 to 0.029)	0.708
High myope	–0.026 (–0.069 to 0.017)	0.239
Fovea attached	**–0.038 (–0.073 to –0.004)**	**0.030**
U-tear	–0.039 (–0.080 to 0.002)	0.061
(Intercept)	–0.065 (–0.171 to 0.040)	0.227
Pseudophakic preoperatively	**–0.069 (–0.115 to –0.022)**	**0.004**

PVR, proliferative vitreoretinopathy; RD, retinal detachment; VA, visual acuity.

Finally, the potential influence of DrR on final BCVA was evaluated. Final median BCVA did not significantly differ between the two groups, confirming the limited impact of postop ERM on final VA. The trend towards worse BCVA as well as the lower VA gain in the subgroup of fovea involving RD in patients receiving DrR on univariable analysis may have been driven by poorer prognostic findings at baseline. Established negative prognostic factors for VA, such as poor baseline BCVA, male sex, macular detachment and greater RD extent, were more common in the DrR group.[4] However, it has to be pointed out that our study did not assess other parameters of visual function that may be influenced by performing a DrR, including the position of the DrR. DrRs within five disc diameters of fixation have been associated with significant postoperative visual field defects, which are more extensive with a more posterior location of the DrR.[36] In addition, the lower VA improvement in fovea involving RD where DrR was performed may support other evidence that maximising SRF drainage does not impact significantly final visual outcomes.[37 38] On the other hand, a recent post hoc analysis of the PostRD randomised controlled trial[29] revealed that DrR was associated with lower objective D-chart distortion at 6-month FU (unpublished data).

We acknowledge that the lack of documentation about the intraoperative use of perfluorocarbon liquid (PFCL) is a limitation of this study. Indeed, PFCL-assisted drainage is commonly considered an alternative to DrR to optimise SRF drainage, particularly in challenging conditions.[15 39] Recent literature suggests that PFCL-assisted drainage may have an impact on the outcomes of RD repair in terms of worse postoperative BCVA and photoreceptor integrity.[24] However, the available evidence on the potential impact of intraoperative use of PFCL during RD repair is controversial for both anatomical and functional outcomes.[12 14 15 24 40] The retrospective design of the study carries a risk of uncontrolled bias and did not allow the analysis of functional parameters other than BCVA. In addition, the surgeon might have reported epiretinal membrane variably as there are not shared criteria for the definition in the database and preoperative OCT was not routinely performed. However, several factors mitigate this risk. The large sample size allowed us to control for variables and explore low incidence complications. The existence of categorisation guidelines and compulsory data fields in the databases minimises variability in data collection and missing data. Surgeons contributing to the databases are asked to record the data prospectively, and, although we are not able to verify this, the selection of regular contributors can reduce selection bias optimising the representation of continuous surgical outcomes from independent surgeons. The relatively short mean FU may result in the underestimation of postoperative epiretinal membrane rate; however, we would expect this aspect to have an impact on both groups as they did not differ in terms of median FU. The RD drawing tool does not measure the distance of retinal findings from the equator; thus, the potential impact of the anterior/posterior location of the DrR could not be assessed. Finally, with regard to preoperative OCT, it is important to note the absence of such imaging in all eyes with RRD may reflect a real-world scenario, where RRD is often diagnosed and managed in emergency settings. Furthermore, the presence of macular involvement can hinder the acquisition of high-quality preoperative OCT scans, potentially introducing a selection bias.

In conclusion, our study confirmed the association between DrR and the development of ERM after RD repair. Other surgical outcomes, including postoperative BCVA, SSAS and postoperative macular folds, do not appear to be influenced by DrR. These findings, along with the recent evidence of the limited impact of residual SRF (once retinal breaks are closed) on final BCVA and primary reattachment rate after RRD repair,[37 38] and the marked variation in practice between surgeons, suggest there is a need for further research to identify when, if ever, DrR should be used.

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