·Clinical Research·

Missed retinal breaks in rhegmatogenous retinal detachment

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Received: 2016-02-01 Accepted: 2016-04-27

Abstract

• **AIM: To evaluate the causes and associations of missed retinal breaks (MRBs) and posterior vitreous detachment (PVD) in patients with rhegmatogenous retinal detachment (RRD).**

• **METHODS: Case sheets of patients undergoing vitreo retinal surgery for RRD at a tertiary eye care centre were evaluated retrospectively. Out of the 378 records screened, 253 were included for analysis of MRBs and 191 patients were included for analysis of PVD, depending on the inclusion criteria. Features of RRD and retinal breaks noted on examination were compared to the status of MRBs and PVD detected during surgery for possible associations.**

• **RESULTS: Overall, 27% patients had MRBs. Retinal holes were commonly missed in patients with lattice degeneration while missed retinal tears were associated with presence of complete PVD. Patients operated for cataract surgery were significantly associated with MRBs (P=0.033) with the odds of missing a retinal break being 1.91 as compared to patients with natural lens. Advanced proliferative vitreo retinopathy (PVR) and retinal bullae were the most common reasons for missing a retinal break during examination. PVD was present in 52% of the cases and was wrongly assessed in 16%. Retinal bullae, pseudophakia/aphakia, myopia, and horse shoe retinal tears were strongly associated with presence of PVD. Traumatic RRDs were rarely associated with PVD.**

• **CONCLUSION: Pseudophakic patients, and patients with retinal bullae or advanced PVR should be carefully screened for MRBs. Though Weiss ring is a good indicator of PVD, it may still be over diagnosed in some cases. PVD is associated with retinal bullae and pseudophakia, and inversely with traumatic RRD.**

• **KEYWORDS:** missed retinal breaks; retinal detachment; ocular examination; posterior vitreous detachment; retinal surgery

DOI:10.18240/ijo.2016.11.15

Takkar B, Azad S, Shashni A, Pujari A, Bhatia I, Azad R. Missed retinal breaks in rhegmatogenous retinal detachment. *Int J Ophthalmol* 2016;9(11):1629-1633

INTRODUCTION

Undoubtedly, the single most important step in surgery for rhegmatogenous retinal detachment (RRD) is to anatomically seal the retinal break. This principle adopted since the era of Gonin nearly a century ago, is well reflected in the current literature too [1]. Missed retinal breaks (MRBs) are responsible for up to 64% of the cases of failed retinal detachment surgery [2-10]. Furthermore, new techniques for reducing MRBs continue to develop in pursuit of the perfect retinal detachment surgery[11-14].

Posterior vitreous detachment (PVD) is central to pathogenesis and treatment of RRD. PVD is present in nearly 50% of patients above 50 years of age [15]. It is marked by the presence of Weiss ring on clinical examination. With ageing, vitreous liquefies (synchisis) and collapses (syneresis) on itself leading to complete PVD. As residual attached cortical vitreous can lead on to retinal breaks due to vitreous traction, failure to identify PVD preoperatively, specially in cases of RRD being treated with conventional procedures dependent on ophthalmoscopic examination, can hamper surgical results[16]. The current literature is full of reports on techniques focusing on easier and safer separation of cortical vitreous from the internal limiting membrane, further underlining its importance [17-20]. Moreover, vitreoschisis *i.e.* splitting of posterior vitreous cortex (PVC) can obscure an incomplete PVD, thus leading to its over estimation.

This study compares clinical findings to those visualized during vitreo retinal surgery (VRS) and aims to identify the causes of MRBs. We also ascertain associations of PVD in cases of RRD and cases in which PVD status may be wrongly assessed preoperatively.

SUBJECTS AND METHODS

The study was conducted in accordance with the Declaration of Helsinki. Patients of RRD who underwent VRS at a Tertiary Care Center of Northern India, between 2011-2013, were identified through operation theatre records and their case sheets retrieved. All case sheets had detailed preoperative and intraoperative hand drawn retinal charts (Modified Amsler-Dubois Scheme). A total of 378 case

sheets were then analyzed comprehensively for clinical findings and surgical notes by 2 authors (Takkar B and Azad S, both senior fellows) and only records meeting consensus, separately for MRB and PVD, were included. Patients below 12 years of age (uncooperative for examination) or with media haze >Grade 1 [21] were excluded. Patients with previous history of VRS were also excluded. Patients with combined RRD were excluded for evaluation of PVD. Finally out of the 378 patients, 253 eyes were included for analysis of MRB and 191 eyes for evaluation of PVD. Data including complete ocular examination with focus on extent of retinal detachment (RD), retinal breaks with location, retinal degenerations, status of proliferative vitreo retinopathy (PVR), presence of complete PVD and lens status was noted. Examination had been performed with a combination of direct and indirect ophthalmoscope, along with 90 D lens assisted slit lamp biomicroscopy. Surgical notes were specifically evaluated for discovery of MRBs, their type and location, discovery or induction of PVD. Iatrogenic breaks were carefully identified and excluded while analyzing MRB. In all the cases, cortical vitreous had been stained with triamcinolone acetate by the surgeon. Presence of Weiss ring was defined as complete PVD[22]. Missed PVD was defined as presence of complete PVD noted during surgery but missed during ophthalmoscopy. PVR was graded as per Silicone Oil Study classification system[23]. Traumatic RDs were identified as per pre-existing criteria [24]. Patients with history of refractive error >-3.00 D were identified to be myopic.

Statistical Analysis Association of MRBs with Lincoff's rules for RRD was also analyzed [25]. Lincoff's rules were considered to be not applicable in absence of pre-existing causative break and presence of total RD. All surgical records having MRBs were specifically re-evaluated for possible reasons for missing the retinal breaks preoperatively. This data has been presented separately in results section. Microsoft Office Excel sheets were used for data compilation which was then analyzed with SPSS software (Version: 16). Pearson chi-square test, paired Student's *t*-test and odds ratio were used for analysis. Two sided *P* value less than 0.05 was considered to be statistically significant.

RESULTS

Missed Retinal Break Mean age of the patients was 39.99±20.43y (range, 12-85y) and 79% (n=199) were male. Fifty-nine (23%) cases had trauma related RD, while 47 (19%) patients had myopia. Single retinal break was identified in 107 eyes, more than 1 break in 77 eyes while no break could be identified in 69 eyes preoperatively. PVR greater than Grade C was present in 75 (30%) patients. Lattice degeneration was identified in 75 (30%) patients while preoperative complete PVD was noted in 132 (52%) patients. Total RRD was present in 138 (55%) patients. Overall, 114 (45%) patients were phakic, 29 (11%) had cataract, 95 (38%) were pseudophakic and 15 (6%) were aphakic. Lincoff's rules were not applicable in 166 patients.

Table 1 Missed breaks-what was missed? *n* (%)

Parameters	MRBs
Patients with MRBs	69 (27)
Mean number of MRBs	1.56±1.35 (range 1-4)
More than 1 MRB	22 (32)
Type of MRBs	
Retinal tear	35 (50)
Retinal hole	21 (31)
Retinal dialysis	7 (10)
Ragged retinal break	6 (9)
Quadrant of MRBs[1]	
Same as causative retinal break	9 (13)
Different from causative retinal break	17 (25)

[1]In patients with missed breaks, no causative break had been seen on examination in 43 (62%) patients. MRBs: Missed retinal breaks.

Missed retinal break: what was missed? MRBs were detected in 69 (27%) patients while no break could be identified in 26 eyes (10%) during surgery. More than one MRB was noted in nearly one third of these patients. Half of the MRBs were retinal tears. Importantly, most of the MRBs were detected away from the quadrant of the causative break. The details have been presented in Table 1. Holes (66%) were the most common type of MRB in presence of Lattice degeneration (P=0.046) while retinal tears (78%) were the most common type of MRB in presence of preoperative PVD (P=0.000).

Missed retinal break: when were they missed? Nearly one third of the patients with cataract, pseudophakia and aphakia had MRBs, as compared to 18% of the patients with crystalline lens (P=0.033). MRBs were also significantly associated with cases in which Lincoff's rules were not applicable (P=0.001). No statistically significant results were found with rest of the variables (Table 2). The odds for missing a retinal break in patients operated for cataract surgery *vs* those with natural lens were 1.91 (P=0.023; 95% CI 1.09-3.33).

Missed breaks: why were they missed? Two authors (Takkar B and Azad S) independently re-evaluated the case records with MRBs specifically to ascertain the possible cause of missing a retinal break on examination. Upon common consensus, PVR greater than Grade C2 (anterior or posterior) was believed to be the most common reason, seen in 16 patients with MRB. Retinal bullae were found to be responsible in 11 patients, and neovascular fronds and hazy media in 8 patients each. Other reasons included anterior retinal break, high myopia, choroidal detachment, high buckle indent of previous scleral buckling, retinoschisis and retinal break located on the edge of a choroidal coloboma.

Table 2 Missed breaks-when were they missed? *n* (%)

Parameters	No. of patients	Patients with missed breaks	*P*
Preoperative break			0.000
None	69 (27)	43 (63)	
Single break	107 (42)	17 (16)	
More than 1 break	77 (31)	9 (12)	
PVR Grade C			0.228
Present	75 (30)	22 (30)	
Absent	178 (70)	47 (26)	
Lattice degeneration			0.141
Yes	75 (30)	14 (19)	
No	178 (70)	55 (31)	
Preoperative PVD			1.000
Yes	132 (52)	36 (27)	
No	121 (48)	33 (27)	
Extent of RD			0.216
Total	138 (55)	42 (30)	
Others	115 (45)	27 (23)	
Lincoff's Rule			0.001
Not applicable	166 (66)	58 (35)	
Explain break location	66 (27)	8 (12)	
Do not explain location	21 (8)	3 (14)	
Lens status			0.033
Phakic	114 (45)	21 (18)	
Cataract	29 (11)	10 (35)	
Pseudophakic	95 (38)	33 (35)	
Aphakic	15 (6)	5 (33)	

PVR: Proliferative vitreo retinopathy; PVD: Posterior vitreous detachment; RD: Retinal detachment.

Table 3 Associations of PVD *n* (%)

Parameters	*n*	Complete PVD	*P*
PVR Grade C	191		>0.05
Present	62	31 (50)	
Absent	129	69 (53)	
Lattice degeneration	191		> 0.05
Yes	42	24 (57)	
No	149	76 (51)	
Extent of RD	191		>0.05
Total	106	58 (55)	
Others	85	42 (49)	
Lens status	191		<0.001
Phakic	112	41 (37)	
Others	79	59 (75)	
Myopia	191		0.02
Yes	34	24 (71)	
No	157	76 (48)	
Trauma	191		< 0.001
Yes	41	10 (24)	
No	150	69 (46)	
IOP<10 mm Hg	175		1.0000
Yes	39	21 (54)	
No	136	71 (52)	
Retinal bullae	164		<0.001
Yes	46	42 (91)	
No	118	22 (19)	
Horse shoe tears	179		0.002
Yes	61	42 (69)	
No	118	46 (39)	

PVR: Proliferative vitreo retinopathy; PVD: Posterior vitreous detachment; RD: Retinal detachment; IOP: Intraocular pressure.

Posterior Vitreous Detachment Mean age of the 191 patients was 40y, 34 were myopic while 41 had trauma related RRD. Complete PVD was confirmed during surgery in 100 (52%) patients. PVD was wrongly diagnosed in 16% of patients-missed on examination in 13 patients and over diagnosed in 18 patients. On analysis, statistically significant variation of PVD was found with lens status, myopia, trauma, retinal bullae and preoperative horse shoe retinal tear (HST). Details have been presented in Table 3. On comparing cases of missed PVD to those with over diagnoses of PVD, no statistically significant data was found.

DISCUSSION

MRBs are a crucial concern as they can lead to recurrent RD, causing additional burden on health resources and also compromising visual gain [26]. We found MRBs in 27% of our patients, which is within the broad range of previously published studies [2-10]. While these studies focus on MRBs being the cause of surgical failure, current literature lacks in reasons for missing retinal breaks in the first place. To the best of our knowledge, our study is the first to compare preoperative ophthalmoscopy findings to surgical findings, thus identifying the associations and causes of MRBs.

Among the 69 cases with MRBs, 22 (one third) were found to have more than a single MRB. Fourteen of these 22 patients were pseudophakic. Also a large number of MRBs, 25% were present in a retinal quadrant different from that of the causative break. These cases are therefore prone to surgical failure, especially when ophthalmoscopy is used for visualization during surgery, for example in scleral buckling and pneumatic retinopexy. The odds of finding a MRB in patients operated for cataract than otherwise were almost double. Previously also, studies have specifically stressed on improving examination techniques in pseudophakic patients[27], who are known to have multiple retinal breaks.

We found MRBs to be significantly associated with conditions where Lincoff's rules were not applicable (more than 80%). This group comprised of 166 patients, of which 138 had total RD and in 69, no break was found on examination. It is easier to find retinal beaks in RD with a particular shape and these results therefore reflect inclusion bias. Hence we analyzed the remaining 87 patients in whom the Lincoff's rules were applicable. We found no significant association of MRBs with RDs not explained with these rules. Thus other factors, apart from retinal breaks, may also

govern the flow of fluid below the detached retina.

Although we found no association of MRBs with PVR or even the type of PVR (folds *vs* subretinal bands), on univariate analysis of retinal charts with MRBs, advanced PVR appeared to be the most common reason for missing a retinal break. These contrasting results may be due to inability to differentiate between "the frequent" iatrogenic [28] and missed retinal breaks in VRS for RRD complicated with PVR. For example, retinal breaks detected during membrane or subretinal band removal may have been wrongly labeled as iatrogenic breaks. Another common reason for MRBs was retinal bullae. Retrospectively, we believe examining patients in both supine and sitting position and also after overnight bed rest/patching when indicated may help in detection of such MRBs in presence of retinal bullae [29]. In cases with neovascular fronds, careful slit lamp assisted biomicroscopy especially in the areas with fibrotic membranes, may help in uncovering MRBs. Scleral depression will help in cases with anterior and small retinal breaks.

We found PVD to be present in slightly more than half of our cases. For, preoperatively noted predictability of Weiss ring as a marker of complete PVD, the positive likelihood ratio was found to be 4.40 and negative likelihood ratio was 0.16. Hence, presence of the Weiss ring is an accurate indicator for diagnosing complete PVD. We reflect that confusing degenerative vitreous or vitreoschisis with "collapsed" Weiss ring can lead to over diagnosis at times while missing the Weiss ring is essentially linked with the peculiarities of the RRD and the examination technique.

Retinal bullae were found to have the highest odds (45.1) of having PVD, followed by pseudophakic or aphakic patients (5.1), non-traumatic RRD (3.6), RRD with retinal horse shoe tear (3.4) and myopia (2.6) in descending order. Presence of retinal bullae indicates free flow of subretinal fluid which essentially would depend on features of retinal break and vitreous liquefaction. Occurrence of complete PVD, apart from being itself a consequence of vitreous liquefaction and syneresis[30], allows free movement of liquefied vitreous in the space between the retina and the detached cortical vitreous, which in turn can result in retinal bullae. Effect of lens status on PVD has been discussed previously and correlates with the findings of our study [31]. Similarly, associations of HST and myopia with PVD are as expected[32-33]. We also observed traumatic RRD to be inversely associated with PVD. Ragged margin tears and retinal dialysis seen in trauma related RRDs are due to contusion or equatorial expansion of the globe seen in blunt trauma [34-35]. As young patients are predominantly exposed to ocular trauma, one may expect these kind of RRDs to be seldom associated with PVD. However, on analyzing trauma related RRD on the basis of duration of trauma, cases in which more than 6mo had elapsed since trauma at presentation, had three times higher odds of having PVD as compared to rest. This result was nearly statistically significant (P=0.0571). This reflects that PVD can occur after blunt ocular trauma, though it may be delayed.

Table 4 Incorrect diagnoses of PVD

Feature	Missed PVD	Over diagnoses of PVD
PVR	3	5
Lattice degeneration	3	5
Lens status		
Phakic	9	13
Others	4	5
Myopia	5	8
Trauma	0	3
HST	0	0

PVD: Posterior vitreous detachment; RD: Retinal detachment; HST: Horse shoe retina tear.

In a minority of cases, there is a discord between rate of synchisis and syneresis, anomolous PVD can occur leading to vitreoschisis and a false Weiss ring resulting in over diagnosis [36]. In such cases complete PVD can be mistaken and requires intraoperative Triamcinolone assisted staining for confirmation [37]. We diagnosed PVD in 18 patients preoperatively where we had to induce PVD again during surgery. However, we could not statistically pinpoint any single feature of RRD linked to over/missed diagnoses of complete PVD. Failure to confirm for PVD intraoperatively can lead to PVC remnants, which may lead to formation of epiretinal membranes, thus jeopardizing successful retinal reattachment post operatively.

A major limitation of this study is inclusion of a large number (59) of trauma related RDs. No retinal break could be identified in nearly 10% of patients, which is a higher number than expected. This could be due to retrospective nature of the study. Also multiple examiners were involved in either evaluating or operating the patients, hence, findings may have varied. To some extent these limitations were overcome by including only the data meeting consensus of the authors. Due to small numbers, we could not compare cases of missed and over diagnosed PVD with the rest of the sample. There characteristics have been presented in Table 4.

In conclusion, retinal breaks are frequently missed during examination of patients with RRD, especially those with pseudophakia. Cases with PVR and bullous RD should be carefully examined for MRBs. Although presence of Weiss ring is highly predictive for complete PVD in RRD, PVD may be wrongly diagnosed in some cases. PVD is strongly associated with retinal bullae, pseudophakia, myopia and retinal tears while it is inversely associated with traumatic RRD.

ACKNOWLEDGEMENTS

Conflicts of Interest: Takkar B, None; **Azad S,** None; **Shashni A,** None; **Pujari A,** None; **Bhatia I,** None; **Azad R,** None.

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