BMJ Open Ophthalmology

Retinal detachment in retinitis pigmentosa

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To cite: Chan WO, Brennan N, Webster AR, *et al*. Retinal detachment in retinitis pigmentosa. *BMJ Open Ophthalmology* 2020;**5**:e000454. doi:10.1136/bmjophth-2020-000454

Received 12 February 2020
Revised 23 April 2020
Accepted 3 June 2020

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ABSTRACT

Objective Retinitis pigmentosa-related retinal detachment (RPRD) is rare, and the full spectrum of retinal complications is not well defined. To describe the types of retinal detachment in patients with retinitis pigmentosa and the surgical outcomes of RPRD.

Methods This is a non-comparative, retrospective case series. An electronic database search was performed using Moorfields OpenEyes electronic health records. We identified 90 patients with RPRD between January 2000 and August 2017. Main outcome and measures are visual acuity (VA), surgical outcomes and classification of RPRD.

Results Of the 90 patients/detachments, 61 (67.8%) were rhegmatogenous retinal detachment (RRD), 19 (21.1%) were exudative, 3 (3.3%) were tractional retinal detachment (TRD) and 7 (7.8%) had combined. 37.5% (9/24) of patients with exudative retinal detachment were treated with either cryotherapy or laser, and one patient underwent vitrectomy for vitreous haemorrhage. 56/90 patients underwent surgical intervention. Nine patients presented late and were deemed inoperable (two exudative and seven RRD). Of the RRD patients with full operative record, the primary attachment rate was 76.2% (16/21) and final reattachment rate was 85.7% (18/21) over a mean 15.4-year follow-up period. Mean VA for RRD surgery improved from 6/190 (1.51 logMAR) to 6/120 (1.31 logMAR) (p=0.194). In the TRD group, the mean VA was 6/300 (1.66 logMAR) at baseline and improved after surgery to 6/48 (0.90 logMAR) (p=0.421).

Conclusions We demonstrated a final reattachment rate of 85.7% with a trend toward better vision following intervention for patients with RPRD. However, the final long-term vision may be poor due to the natural progression of retinitis pigmentosa-associated macular degeneration.

Key messages

What is already known about this subject?

- To date, there have been two case series describing the outcomes of retinitis pigmentosa-related retinal detachment which report high (91%, 95%) reattachment rates with a distinct absence of posterior vitreous detachment (PVD)-related pathological breaks and mixed pattern of causative breaks.
- In our retrospective case series at a large tertiary centre, we present the full spectrum of retinal detachment (RD) observed in patients with retinitis pigmentosa (RP), and the visual and surgical outcomes of surgery for RD over a long-term follow-up period.

What are the new findings?

- We have demonstrated in a large series of 90 patients that up to 68% of retinal detachments in patients with RP are rhegmatogenous in nature. Rhegmatogenous detachment in RP is characterised by an absence of complete PVD with a predominance of round hole detachments, with a younger age group affected, and high rates of primary proliferative vitreoretinopathy. From our surgical outcome cohorts, we established a final reattachment rate of 85.7% for patients with RP that is favourable compared with vitrectomy surgery for conventional primary RD surgery in adults without RP.

INTRODUCTION

Retinitis pigmentosa (RP) is rarely associated with retinal detachment (RPRD).[1 2] The reported prevalence of retinal detachment ranges from 0.7% to 1.3%.[1 2] Understanding RPRD would also indirectly shed light into the proposed anomalous interaction of the vitreous–retina and neurosensory retina–retinal pigment epithelium in RP. With increasing application of artificial implants, stem cell treatments and gene therapy for different stages of RP, there is an increasing need to better understand the natural history of RPRD.

The literature is sparse regarding retinal detachment incidence, the distribution of types of detachment and the outcomes of RPRD. To date, there have been two case series describing the outcomes of RPRD. Dave *et al*[1] reported 16 patients with high reattachment rates of 91% with a distinct absence of posterior vitreous detachment (PVD)-related pathological breaks, while Rishi *et al* reported high rates of primary success rates of 95.6% in 31 eyes at 33 months with a mixed pattern of causative breaks.[1 2]

In our retrospective case series at a large tertiary centre, we present the full spectrum of RD observed in patients with RP, and the visual and surgical outcomes of surgery for RD over a long-term follow-up period.

Key messages

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

- There are a number of surgical considerations when treating RD in RP. As the vitreous is often attached, the use of triamcinolone acetonide as an adjuvant to stain the vitreous is useful. Laser threshold burns can be difficult to titrate on the presence of thin RP retina and there is a lack of laser burn visualisation in RP retina. Application of 100–200 ms laser retinopexy burns that appear subvisible would still create an outer retinal adhesion, so care should be taken not to overtreat the retina of patients with RP as there is a risk of necrosis at the edges of laser scars in future. In patients with single horseshoe tear and no PVD, a scleral buckle procedure is recommended, and this was very successful in our series. An external drain is advisable to drain the subretinal fluid as the RPE pump is dysfunctional in RP and this avoids persistent subretinal fluid that remain long term. During vitrectomy, there can be difficulty detaching the vitreous from over areas of retinal holes/tears and so the placement of a segmental scleral buckle over the primary breaks is helpful.

METHODS

This is a non-comparative, retrospective case series. An electronic database search was performed on Moorfields OpenEyes electronic health records.

An electronic search strategy of all legacy letters containing these phrases ("retinitis pigmentosa", "vitrectomy", "retinal detachment", "exudative", "traction") between 1 January 2000 and 31 December 2009 was implemented. 143 patients were identified from "retinal detachment" [and] "retinitis pigmentosa" between 1 January 2000 and 16 August 2017. 65 patients were identified from "vitrectomy" [and] "retinitis pigmentosa". 14 patients from "vitrectomy" [and] "retinitis pigmentosa" [and] "retinal detachment." After accounting for any potential duplicates, our search yielded a total of 188 records. We performed systematic case notes review on the 188 records and identified 90 eyes of 76 patients with confirmed RPRD, including 14 patients with bilateral involvement. Of these, only 21 had complete records of surgical management. Descriptive analysis of types of RD were performed for all identified patients (90 eyes). Patients were excluded from surgical outcome analysis if there were incomplete notes of their RD repair (repair done privately, done at other hospital, or inaccessible/archived legacy paper notes).

All analysis was performed using SPSS Statistics for Windows (released 2017, V.25.0; IBM, Armonk, New York, USA). Summary statistics were performed for descriptive variables and paired t-test was used for within group testing. A p-value<0.05 was considered statistically significant.

There was no patient or public involvement in the design or production of the manuscript.

RESULTS

We identified 90 patients with RPRD. Pure rhegmatogenous detachment was noted in 61 (67.8%) patients, exudative only detachment in 19 (21.1%) patients and tractional only in 3 (3.3%) patients. Combined tractional and exudative detachment was noted in five (5.6%) patients and combined tractional and rhegmatogenous was noted in two (2.2%) patients. Of these patients, 56 (62.2%) patients underwent surgical intervention, 25 (27.8%) were managed conservatively by observation and 9 (10%) patients were deemed inoperable at presentation.

All 22 patients with exudative detachment, including 2 patients with total detachment did not require surgical repair for the detachment. There were seven cases of crumbs homolog 1 (CRB1)-associated retinopathy with exudative detachments.

Of the patients with tractional retinal detachment (TRD), three patients had surgical management due to macula involvement and the rest were managed conservatively as the macula was not threatened. Of the total 61 patients identified with rhegmatogenous retinal detachment (RRD), 7 (11.5%) had severe proliferative vitreoretinopathy (PVR) and were deemed too advanced for surgical intervention with a poor visual and anatomical prognosis.

There were complete surgical records for 21 eyes out of 56 patients who underwent surgical intervention for RP-related retinal detachment. Mean age of presentation was 32.8 years (n=21, range 7 to 51 years). There were 11 men and 10 women. There were no cases of traumatic retinal detachment in the 21 eyes, and no cases of RD following cataract surgery within 1 year. The mean follow-up duration was 15.4 years (1 year to 30 years). For patients with RRD, 13/18 presented acutely with mean duration of symptoms of 2.9 days (range 1–14 days). 5/18 presented with symptom duration of >4 weeks. Of the three patients with TRD, two patients had symptom duration of 3 days and one had symptoms for >4 weeks.

We had complete genomics data for 23 patients, and table 1 summarises the type of detachments and associated comorbidities noted in this group.

Of the patients with full genomic analysis, we had full surgical records for 16/23. All the patients with RRD underwent successful surgery with one failure of the *MYO7A* genotype, and one case that was deemed inoperable due to severe ocular trauma. None of the patient with exudative detachments had surgery for RD. There was a high number of RRD patients with USH2A and it is unclear as to why this may be a potential risk factor. Apart from NRL and PRPF31, all others are AR or XL. It is worth noting that X-linked RP is almost always associated with myopia which itself is a risk factor for retinal detachment.

Table 2 outlines the types of pathological breaks confirmed intraoperatively in cases of RRD and TRD and the degree myopia associated with each break. Of the three cases of tractional detachment, two cases were associated with traction-related holes and one case was associated with macular involving traction that necessitated surgery.

Table 1 Patients with full genomic data and associated type of retinal detachment and comorbidities

Type of detachment	Gene	Base change	AA change	Associated comorbidities	Surgery outcomes
Exudative	*EYS*	c.6137G>A	p.Trp2046Ter		Cryotherapy x1
Exudative	*NRL*	c.148T>A	p.Ser50Thr		Cryotherapy x1
Exudative	*PRPF31*	c.356C>T	p.S119X	Myopia	Cryotherapy x1
Exudative	*RDH12*				No surgical data
Exudative	*USH2A*	Large deletion EX 50–55			Cryotherapy x1
Exudative and tractional	*CRB1*	c.3879–1203C>G	p.R764C		Cryotherapy x1
Exudative and tractional	*CRB1*	c.3074G>A	p.S1025A		Cryotherapy x1, progressed—inoperable
Rhegmatogenous	*BEST1*	c.682G>A	p.(Asp228Asn)	Myopia	Successful reattachment after x1 PPV
Rhegmatogenous	*FAM161A*	c.1309A>T	p.Arg437Ter	Divergent squint	Successful reattachment after x1 PPV
Rhegmatogenous	*IMPG2*	c.2928delC	p.(ALa1011Phefs)		Truama—ruptured globe—total RD—inoperable
Rhegmatogenous	*MYO7A*	c.977 T>A	Leu326Gln		Successful reattachment after x1 PPV
Rhegmatogenous	*MYO7A*	c.2914C>T	Arg972X	Hearing loss	Successful cryotherapy/buckle
Rhegmatogenous	*MYO7A*	c.3719G>A	Arg1240Gln	Hearing loss	X3 PPV—failed surgery—detached under oil
Rhegmatogenous	*NR2E3*	IVS1-2			Buckle—failure
Rhegmatogenous	*RP2*	c.852delA	p.Ala285HisfsTer8	Myopia	No surgical data
Rhegmatogenous	*RPGR*	g.ORF15+652_653delAG		Macular disciform scar Myopia	Successful reattachment after x1 PPV
Rhegmatogenous	*RPGR*			Myopia	Successful reattachment after x1 PPV
Rhegmatogenous	*USH2A*	c.1328+36_39delGATT		Hearing loss	Successful reattachment after x1 PPV
Rhegmatogenous	*USH2A*	c.2299delG	Glu767serfsX21	Hearing loss	Successful reattachment after combined PPV/buckle
Rhegmatogenous	*USH2A*	c.1328+36_39delGATT		Hearing loss	Successful reattachment after x1 PPV
Rhegmatogenous	*USH2A*	c.5776+1G>A		Hearing loss	Successful reattachment after combined PPV/buckle
Rhegmatogenous	*USH2A*	c.3737dupT	p.Ser1247LysfsTer4		No surgical data available
Rhematogenous and tractional	*RP1*	c.2596_2597delTT			Successful reattachment after combined PPV/buckle

AA, amino acid; PPV, pars plana vitrectomy ; RD, retinal detachment.

Table 2 Details of retinal breaks and refractive error in 21 patients with complete surgical data

Type of causative break	n	Full breakdown of location of break	PVD	Refractive error (mean spherical equivalent)
Horseshoe tear	5	1. Anterior edge of peripheral spicules/lattice at 11 o'clock 2. Anterior edge of peripheral spicules/lattice at 6 o'clock 3. Single HST within spicules/lattice within RD 4. HST within spicule at edge of staphyloma 5. Superior anterior retina within spicules/lattice at 12 o'clock	All cases had partial PVD overlying tears	−8.90
Retinal round hole	13	1. Border of spicules/lattice at 3 o'clock 2. 9 o'clock 3. Superior temporal quadrant 4. 3 o'clock 5. Multiple holes in temporal quadrant 6. Superior temporal quadrant 7. Within superior pre-equatorial lattice 8. Within lattice/spicules area at posterior pole 9. Atrophic holes in all quadrants 10. Nasal quadrant 11. Nasal quadrant 12. Inferior nasal quadrant	No cases had PVD	−7.50
Macular hole	1	1. Large macular hole	No PVD present	−17.25
No break found	1	Not applicable	No PVD present	Not myopic
Retinoschisis/outer leaf break	1	Superior retinoschisis	No PVD present	Not myopic
Total	21			

HST, horse shoe tear; PVD, posterior vitreous detachment; RD, retinal detachment.

Outcomes of retinal detachment surgery

Primary reattachment rate was 16/21 (76.2%); final reattachment rate was 18/21 (85.7%) over a mean follow-up period of 15.4 years. Of the 5/21 patients that redetached, 3/21 elected not to have any further operation after failed vitrectomy (VCG) and oil surgery. There was no common underlying genetic links in this failure group.

Table 3 Type of retinal detachment repair and respective outcome of reattachment

	Detached	Attached	Total
Segmental scleral buckle, retinopexy	0	3	3
Combined vitrectomy and buckle, retinopexy, gas	0	4	4
Vitrectomy with delamination, retinopexy, gas	0	1	1
360 encirclement with scleral buckle, retinopexy	0	1	1
Vitrectomy, retinopexy, gas	2	6	8
Vitrectomy, retinopexy, silicone oil	3	1	4
Total	5	16	21

Table 3 summarises the type of operation performed and their outcomes. Surgical success based on type of surgery was: 100% for buckle, 100% for combined, 100% for delamination, 100% for encirclement, 75% for VCG, and 25% for vitrectomy, cryotherapy and silicone oil. Of the four cases who underwent VCG and primary silicone oil tamponade, the indications were grade C PVR, no intraoperative break found, subtotal RRD secondary to horseshoe tear and total RRD secondary to giant retinal tear. Retinal redetachment occurred in three of four patients and further surgery declined so they remained redetached under oil. We analysed the causes of failure in our series, and two of the redetachment cases was due to anterior PVR associated with cyclitic membrane, which reattached with subsequent vitrectomy and peeling surgery. One of these cases presented 9 years after initial surgery. The other three patients declined further surgery after two operations.

Best-corrected visual acuity (VA) outcomes

For all types of retinal detachment, there was a trend toward VA improvement between baseline 6/190 (1.53 logMAR) and final postoperative visit 6/95 (1.25 logMAR) (p=0.098). When stratified for RRD versus TRD, in both groups there was a trend toward VA improvement but this did not achieve statistical significance for patients at

final follow-up. The mean VA improved from 6/190 (1.51 logMAR) before RRD surgery to 6/120 (1.31 logMAR) (p=0.194). However, the final VA trend was for gradual worsening due to RP-related macular atrophic degeneration and/or optic neuropathy in 11/61 cases (18%). Neovascular glaucoma and ocular phthisis developed in 4/61 cases (6.6%). In the TRD group, the mean VA was 6/300 (1.66 logMAR) at baseline, and this improved after surgery to 6/48 (0.90 logMAR) (p=0.421).

Complications

There were no cases of intraoperative complications. Postoperatively, there were five cases of retinal redetachment, three cases of high intraocular pressure (range 38 mm Hg–52 mm Hg), one case of uveitis-glaucoma-hyphaema syndrome that required lens implant explantation, one case of scleritis and one case of lens implant subluxation.

Outcomes of treatment for exudative retinal detachment

We had a total of 24 patients with exudative retinal detachment (19 exudative only and 5 patients with combined exudative and tractional detachment due to preretinal fibrosis from the Coat's-like vessels). None of these patients underwent retinal detachment surgery, but 37.5% patients (9/24) required cryotherapy or laser to treat sight-threatening exudative retinal detachment and one patient underwent vitrectomy for vitreous haemorrhage. Of the patients who required cryotherapy, four patients were known to have *CRB1*-associated retinopathy.

In 6/24 cases (25%), the final VA trend was for gradual worsening due to RP-related macular atrophic degeneration and/or optic neuropathy. In 4/24 (17%), patients developed neovascular glaucoma with progression to ocular phthisis.

DISCUSSION

RP is associated with a spectrum of exudative, tractional and RRD. In our series, we demonstrated a final reattachment rate of 85.7% for RPRD, with a mean follow-up duration of 15.4 years and median 20 years. Notably, 10% of patients with RP presented with advanced and inoperable retinal detachment. The presence of a complete PVD was 0% and we had a young patient cohort with mean age of 31.5 years at the time of surgical intervention.

Our final reattachment rates were lower compared with other reported series, with Dave *et al*[1] reporting a primary success rate of 91% at 5 months of follow-up, and Rishi *et al*[2] reporting a primary success rates of 95.6% at 33 months of follow-up. Dave *et al*[1] reported a mean delay in RPRD presentation of 14.5 months and similarly Rishi *et al*[2] found a mean presenting duration of RPRD of 12 months with macula-OFF RD. They proposed that the associated loss of peripheral field in RP can account for the lack of awareness of field loss associated with RPRD.[2] In our series, 72% patients presented within 3 days of first symptoms, and 38% patients had macula-ON RPRD. At Moorfields Eye Hospital (MEH), we have a 7-day emergency eye and vitreoretinal service and patients are referred to our centre with this open access service known across the UK. However, we did find 10% of patients presented to our service with advanced and inoperable RRD that would support the hypothesis of other studies.

Rishi *et al*[2] reported success rates of 90% for scleral buckling and 100% for vitrectomy, in 31 RP-associated RRDs. However, the VA improvements were often limited. Our anatomical results were similar with a mean gain in VA of 0.3 logMAR units, and the VA gains are comparable to the study by Dave *et al*[1] who report a 0.34 gain. In our series, we did not observe any cases of postoperative cystoid macular oedema and no other obvious cause for the lack of significant visual gain. The high proportion of patients (62%, 13/21) with mac-OFF detachment may account for the modest visual gain. The vitreous has strong adhesions in RP.[3 4] In our subanalysis, there was no confirmed full PVD in any surgical case.

The temporal relationship of RD according to age can be explained by different mechanisms. The natural history of RP progression leads to pigment migration from the retinal pigment epithelium to the inner retina.[2] Photoreceptor death leads to loss of the subretinal space due to migration of RPE cells into the inner retina and extension of hypertrophied Muller processes outward to the region of Bruch's membrane. Earlier in the RP disease process the volume of the subretinal space shrinks as the photoreceptor outer segments shorten, and the peripheral retina becomes thinner with potential risk of atrophic holes.[5] Following death of all photoreceptors, RPE cells often detach from Bruch's membrane and migrate to perivascular sites in the inner retina producing so-called bone spicule pigment.[6]

The retina develops focal and broad adhesions to the RPE and Bruch's membrane.[7] This creates a retinal pigment epithelium-neurosensory bond with increased protection against retinal detachment.[8] The stiffening and firm adhesion from retinal pigment epithelium pigmentation may be protective from RD in later adult life. RPRD has been hypothesised to occur in younger patients as they lack this protective mechanism, as found in our study. The neurosensory retina–RPE adhesions have not been established in younger patients with RP, hence this age-related difference and a normal incidence for their age of RP-related RD.[8] However, in advanced RP of the elderly, the retina–RPE adhesions are more secure leading to lower rates of RD.

Second, early attrition of hyalocytes in patients with RP may predispose patients to earlier PVD[2] although it is not clearly defined whether patients with RP develop a full and complete PVD with RD onset or whether they develop incomplete and perhaps anomalous PVD known as vitreoschisis. In our study, none of our patients with full intraoperative findings had complete PVD. All our patients with horseshoe tears had incomplete sectoral PVD; this was in keeping with a study by Vingolo *et al* whom

observed PVD in 0.43% of their cohort and found a large proportion of patients with RP had anomalous vitreal alteration that was independent of refractive errors.[4] The mean age of this group of patients was 37.26±14.93 years (range: 5–77 years). When compared with other studies that reported on rates of PVD in younger patient, the 0.43% seems comparable.[9 10] However, the small number of patients and the lack of age specifics in the study by Vingolo *et al* make direct comparison difficult. Several studies have compared the rates of PVD in healthy subjects versus patients with retinitis pigmentosa.[4 10] Hikichi *et al* found that patients with RP had significantly higher rates of PVD across the age groups.[11] Combined, the relative lack of bony spicule formation in younger patients and the earlier onset of anomalous PVD may provide some explanation to the observation of RDs in younger patients with RP.

Dave *et al*[1] found an RPRD prevalence of 0.059% and median presentation of RD at age 32. They found 18% had PVR, and their average time to presentation was 14 months, and a distinct lack of horseshoe tears, giant retinal tears, dialysis and macular hole-related RRD.[1] This is in contrast with Rishi *et al*[2] who found a more varied representation of pathological breaks. In 24% of our patients with RPRD, we found horseshoe tears with incomplete, partial PVD, and 62% patients had round hole-related detachments without PVD. At Moorfields between 2016 and 2018, we performed 2673 emergency surgeries for non-RPRD, and this approximates to around 100 conventional RRD operations per month; in comparison, we could only identify a total of 90 cases of RPRD over a study period of 18 years. We were not able to elucidate the incidence of RPRD from our dataset, but RPRD represents a very small proportion of retinal detachment repair that we perform at MEH. Interestingly, to compare occurrence of RPRD with other inherited retinal disease, we also conducted a separate search of our Moorfields EPR system and were unable to retrieve any cases of retinal detachment associated with Stargardt (n=785) or Best disease (n=261) over the same study period.

Prevalence of myopia of upward of 75% has been reported in patients with RP and up to 95% of patients with X-linked RP.[10 12] Rishi *et al*[2] did not find a difference in rates of myopia or hyperopia for RPRD. In our series, three of our patients had X-linked RP and the aetiological breaks were tractional detachment, hole related and horseshoe tear related, respectively. In our subanalysis of 21 cases, myopia was associated with RD in 17 cases. The mean spherical equivalent was −8.90 dioptres (horseshoe tear), −7.50 dioptres (round hole) and −17.25 dioptres in the case of macular hole. Myopia leads to the formation of retinal lattice and this can increase the risk of retinal breaks.[13 14] Retinal lattice is associated with retinal thinning and vitreous adhesion at lattice margins.[13] However, this stronger outer retinal adhesion has the potential for retinal breaks during peripheral vitreoretinal separation with the risk of a retinal tear, or retinal hole formation in thinned areas of retinal lattice and peripheral bone spicule zones.

In our series, 6/10 (60%), the pathological break was within the area of bony spicules and in 4/10 (40%), the pathological break was immediately anterior to areas of bony spicules or lattice. Specifically, we note that the peripheral vitreous separated in the anterior peripheral zone with single horseshoe tears causing RRD in the nasal and inferior quadrants, and complete RRD. In one case, the vitreous separated from the posterior pole at the edge of a staphyloma with a retinal tear along the thinned staphyloma edge. In all cases of round hole-associated RRD, the vitreous was attached. The most common location of round holes was temporal than nasal quadrants. Single holes at the posterior pole within retinal lattice and bone spicule affected retina led to RRD in three cases. As in other non-RP types of RRD, macular hole and retinoschisis can also be associated with RRD in RP.

Rishi *et al*[2] reported no cases of primary PVR, and Dave *et al*[1] noted 18% of primary PVR despite the long history of presenting duration; one would expect a higher rate of PVR given the chronicity. Dave *et al*[1] hypothesised that lack of viable RPE cells in RP may account for the relative low rates of PVR. We observed 13 cases of primary PVR in our total series of 65 surgical patients that amounts to a 20% PVR rate. Of our cases that redetached, 3/5 eyes had PVR that required revisional surgery. This shows that PVR is still a major cause of operative failure in RPRD and the protective effect of RP on PVR development remains unclear.

There are a number of surgical considerations when treating RD in RP. As the vitreous is presumably attached, the use of triamcinolone acetonide (Kenalog-40; Bristol-Myers Squibb, Princeton, New Jersey, USA) as an adjuvant to stain the vitreous is useful. Vitreoschisis is common with all types of TRD and RRD cases, and so restaining with triamcinolone is helpful with peeling of the posterior vitreous layers from the retinal surface. An internal limiting membrane peel can be performed across the macula in TRD cases and this ensures complete vitreous clearance from macula in macula-involving TRD cases involving the macula.

A protective step in surgical cases is to turn down the light-pipe illumination during vitrectomy to minimise phototoxicity risks.[15] The true effect is difficult to quantify in detached retina and also since the RP retina naturally degenerates over time, electrophysiological testing would be difficult to interpret. Phototoxicity was a historical issue with 20-gauge light sources from 1980s to 1990s but is no longer a recognised risk with modern-day vitrectomy systems.[16]

During treatment of retinal holes and retinal tears, laser titration is important and to avoid overtreatment. Laser threshold burns can be difficult to titrate on the presence of thin RP retina and there is a lack of laser burn visualisation in RP retina. Application of 100–200 ms laser retinopexy burns that appear subvisible would still create an outer retinal adhesion, so care should be taken not to

overtreat the retina of patients with RP as there is a risk of necrosis at the edges of laser scars in future.[17] If there is concern about the therapeutic degree and expected predicted onset of chorioretinal adhesion from retinopexy or cryopexy, then a longer-acting gas tamponade can be considered.

In patients with single horseshoe tear and no PVD, a scleral buckle procedure is recommended, and this was very successful in our series. An external drain is advisable to drain the subretinal fluid as the RPE pump is dysfunctional in RP and this avoids persistent subretinal fluid that remain long term. During vitrectomy, there can be difficulty detaching the vitreous from over areas of retinal holes/tears and so the placement of a segmental scleral buckle over the primary breaks is helpful.

During vitrectomy, a posterior retinotomy can be considered to drain subretinal fluid to expediate retinal attachment and prevent chronic subretinal fluid persistence.

The term 'retinitis pigmentosa' was originally described by Donders as RP was observed to be associated with inflammation, with subsequent degeneration and vascular attenuation.[18] In our series of mainly *CRB1*-associated exudative RD, we found typical microaneurysmal malformations and telangiectatic abnormalities. The retina detaches inferiorly, often bilateral, with Coats-like serous RD.[19 20]

CRB1 disease-causing sequence variants are known to be associated with sparing of para-arteriolar retinal pigment epithelium and retinal telangiectasia with exudation.[21] CRB1 protein is found on the subapical region of photoreceptors and postulated to have important roles in maintaining the integrity of the outer limiting membrane, cell–cell interaction and photoreceptor survival.[22] Exactly why CRB1 is related to phenotypic manifestation of exudation related to telangiectasia is unclear but given that not all patients with CRB1 mutation presented with exudation, den Hollander *et al* has suggested there could be other genes or environmental factors that lead to Coats-like reaction.[21] The spectrum of exudative RD-related telangiectasia can range from non-macula involvement with intact vision to proliferative exudative detachment with end-stage rubeosis and significant visual loss.[21]

The inferior location of the subretinal fluid may be due to the higher specific gravity of subretinal fluid and secondary gravitational effects, and this then leads to chronic hypoxia in the detached retina.[3] Treatment with cryotherapy and/or laser was ineffective in treating the RD with chronic ERD persisting with development of TRD in some cases. High hypermetropia is a common feature of CRB1 retinopathy and ERD, with mean spherical equivalent of +6.30 dioptres (range +3.00 to +13.00 dioptres). Hyperopia is recognised in association with CRB1 retinopathy.[21–23]

There were two patients in our series who presented late with exudative detachment and deemed inoperable. As discussed previously, the therapeutic threshold/endpoint of cryotherapy/laser treatment in RP can be challenging to titrate due to the absence of cryotherapy/laser–tissue interactions. It is somewhat reassuring that no patient in our series of exudative retinal detachment who underwent laser/cryotherapy developed complications of secondary RRD. This suggests that the outer retinal bond is strong in RP.[7 8]

In the long term, the natural history of RP leads to poor vision due to macular atrophy and optic neuropathy. This was observed in 18% RRD and 25% chronic exudative retinal detachment cases. We observed higher rates of neovascular glaucoma and ocular phthisis in the long term with chronic exudative retinal detachment (17%) compared with RRD (6.6%). In these patients, it appeared that despite early therapeutic interventions, the natural history of RP leads to blinding complications in this cohort.

In the era of electronic retinal implant surgery, gene therapy and stem cell treatments for patients with RP, these surgical interventions can involve epiretinal, or subretinal, or even suprachoroidal approaches. Our study did not report any case of retinal detachment following a cataract surgery, vitrectomy surgery or following a previous intraocular retinal procedure in a patient with RP over the 17-year study period at MEH.

The strength of this study includes the large number of patients identified, which allowed us to identify the full spectrum of types of RD that occurs in RP. We also have a sizeable cohort of patient who had complete records of their surgical outcomes and a very long follow-up compared with any previous study.

Limitations

The weakness of our study includes the retrospective nature and a large proportion of our data were incomplete due to us being a quaternary referral centre. While our initial searches identified a large number of patients with RPPD, we were unable to analyse the data as a large proportion of the cases were performed at other centres or the operations were too long ago, and we no longer had access to original operative notes; this meant that we could only analyse one-third of our total available cases. With the popularisation of nationwide registries, one will anticipate we will get a more accurate representation of the outcomes of RPRD. Better standardisation of data collection will also pave the way for registry-based randomised controlled trials.[24]

CONCLUSIONS

We have demonstrated in a large series of 90 patients that up to 68% of retinal detachments in patients with RP are rhegmatogenous in nature. Rhegmatogenous detachment in RP is characterised by an absence of complete PVD with a predominance of round hole detachments, with a younger age group affected, and high rates of primary PVR. From our surgical outcome cohorts, we established a final reattachment rate of 85.7% for patients with RP that is favourable compared with vitrectomy

surgery for conventional primary retinal detachment surgery in adults without RP.

Contributors MMKM planned the study. NB and WOC collected the data. MMKM, WOC, and NB wrote the manuscript. NB submitted the article. ARW and MM provided advice on genetic data collected in the manuscript, and provided assistance with writing the paper.

Funding This work was supported by grants from the National Institute for Health Research Biomedical Research Centre at MEH National Health Service Foundation Trust and UCL Institute of Ophthalmology, Fight for Sight (UK), MEH Special Trustees, Moorfields Eye Charity, Retina UK and the Foundation Fighting Blindness (USA). The corresponding author had full access to all the data in this report and take responsibility for the integrity of the data and the accuracy of the data analysis.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study was approved by the institutional review board of Moorfields Eye Hospital, London.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article.

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