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CLINICAL STUDY

Incidence and indications for pars plana vitrectomy following the treatment of posterior uveal melanomas in Scotland

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Abstract

Background   Globe-sparing treatments such as plaque brachytherapy, local or endoresection, and proton beam therapy (PBT) are the treatments of choice for posterior uveal melanoma. However, both early and late complications can arise from these techniques, including vitreous haemorrhage (VH) and retinal detachment (RD). Choroidal melanomas in Scotland are managed by a single unit, the Scottish Ocular Oncology Service (SOOS).

Methods   Indications and outcomes from surgery were analysed for patients undergoing vitrectomy following treatment for uveal melanoma in the SOOS between 1998 and 2013.

Results   Seventeen from 715 cases (2.4%) required vitrectomy, of which 8/445 (1.8%) followed plaque brachytherapy, 7/43 (16.3%) combined local resection and brachytherapy, and 2/227 (0.9%) PBT. Casenotes were reviewed for 16/17 cases, with surgery indicated for VH in 10 (63%), RD in 5 (31%), and combined VH/RD in 1 (6%). The median interval from initial tumour treatment to vitrectomy was 5.8 months (range 10 days to 8.8 years). Ten (63%) required early vitrectomy (within 6 months), of which the majority (70%) followed combined resection/brachytherapy. Six (37%) required late vitrectomy (after 6 months), of which all were non-clearing VH following plaque brachytherapy, with proliferative retinopathy in 4/6 (67%), and tumour recurrence in 2/6 (33%). Overall vision improved in 8 eyes (50%), remained the same in 2 (12.5%), and deteriorated in 6 (37.5%).

Conclusions   Early vitrectomy was most commonly indicated for RD following local resection, and late vitrectomy for VH due to radiation retinopathy. The majority of patients undergoing vitrectomy gained or maintained vision.

Introduction

Globe-sparing therapy has become the treatment of choice for posterior uveal melanoma following the Collaborative Ocular Melanoma Study (COMS),[1] which showed a similar efficacy and survival after plaque brachytherapy compared with enucleation. In addition to causing less disfigurement, conservative treatments such as brachytherapy, local or endoresection, and proton beam therapy (PBT) have the potential to preserve vision. However, the trend towards globe preservation in small- and medium-sized melanomas carries its own problems, with both early and late complications arising from the treatments themselves and from the regression of the treated tumour. These include vitreous haemorrhage, retinal detachment,[2] glaucoma, and cataract. Before the adoption of globe-sparing therapy, vitreoretinal surgery was primarily a diagnostic tool to provide a biopsy prior to enucleation. However, it is now increasingly called upon in the management of these secondary complications.

The Scottish Ocular Oncology Service (SOOS) is based at the Tennent Institute of Ophthalmology in Glasgow, Scotland. This is a centrally funded tertiary referral unit serving the entire population of Scotland, approximately 5.3 million people.[3] The Tennent Institute also acts as a tertiary referral centre for vitreoretinal surgery for the West of Scotland, as well as providing the service for the SOOS.

The aim of this study is to assess the incidence, indications and outcomes from vitreoretinal surgery following treatment of posterior uveal

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melanoma with local resection, Ruthenium-106 (Ru-106) plaque brachytherapy, and/or PBT.

Materials and methods

The SOOS maintains a mandatory database of all patients referred with suspected ocular malignancies. This database includes patient demographics, diagnosis, treatment, pretreatment and posttreatment visual acuity, and mortality. Using this database, we were able to identify all patients who underwent vitrectomy following treatment for posterior uveal melanoma between 1998 and 2013. Where available, the medical notes were retrieved and reviewed. The age and gender of the patient, size and location of the tumour, and the nature of the tumour treatment were recorded, along with the time interval to subsequent vitrectomy. Outcome measures included anatomical success, final visual acuity, tumour control, and conservation of the globe. Most patients treated by the SOOS for posterior uveal melanoma received life-long follow-up, and the total follow-up time was taken as the last follow-up appointment or the date of death.

All trans-scleral local resections were performed by a single consultant surgeon (EGK). All patients undergoing plaque brachytherapy received Ru-106, with plaques applied by an experienced surgeon (EGK or the ocular oncology fellow). PBT was administered at The Clatterbridge Cancer Centre NHS Trust in Liverpool, England.

Statistical analysis was performed using Microsoft Excel 2007 (Redmond, WA, USA), with statistical significance taken as $P < 0.05$. GraphPad Software (La Jolla, CA, USA)[4] was used to perform Fisher's exact tests to examine associations between vitrectomy for retinal detachment or vitreous haemorrhage, early or late surgery, visual outcome, and any patient, tumour, or treatment factors, all at a two-tailed significance level of 0.05.

Results

Seventeen patients underwent vitrectomy following treatment for posterior uveal melanoma. The casenotes

Table 1 Incidence of retinal detachment and vitreous haemorrhage following treatment of uveal melanoma between 1998 and 2013

Treatment	Retinal detachment	Vitreous haemorrhage
Ru-106 plaque ($n = 445$)	1 (0.22%)	7 (1.57%)
Local resection + Ru-106 plaque ($n = 43$)	4 (9.3%)	3 (7.0%)
Proton beam therapy ($n = 227$)	2 (0.9%)	0 (0.0%)
Total uveal melanoma ($n = 715$)	7 (1.0%)	10 (1.4%)

for 16 patients were available for analysis (the records for 1 patient who underwent PBT could not be retrieved). During this period, 445 eyes were treated with Ru-106 plaque brachytherapy, 43 eyes with combined trans-scleral local resection and Ru-106 plaque brachytherapy, and 227 eyes with PBT (Table 1). Of the 17 patients who underwent vitrectomy, the median age was 54 years (range 23–71 years), 10 (59%) were men, and the right eye was involved in 10 (59%). Of the 16 patients for whom the clinical record could be reviewed, 3 (19%) had ciliary body melanomas and 13 (81%) had choroidal melanomas (of which 5 (31%) were predominantly anterior to the equator, and 8 (50%) were predominantly posterior to the equator). Tumours were located inferonasally in 3 eyes (19%), inferotemporally in 2 (13%), superiorly in 2 (13%), superotemporally in 2 (13%), peripapillary in 2 (13%), nasally in 2 (13%), and with individual cases at the macula, temporally and inferiorly. The mean tumour thickness at presentation was 5.8 mm (range 1.5–12.1 mm), with a mean base diameter of 9.3 mm (5.9–14.3 mm). The primary treatment was Ru-106 plaque brachytherapy in 8 eyes (50%), combined local resection and Ru-106 plaque brachytherapy in 7 eyes (44%), and PBT in one eye (6%). Secondary treatments for recurrence were required in two eyes (13%), one receiving diode laser and the other diode laser followed by PBT, the primary treatment in these cases being combined local resection and Ru-106 plaque and monotherapy with Ru-106 respectively. The median total follow-up time after initial tumour treatment was 3.7 years (range 3 months–14 years). The total follow-up time exceeded 1 year in 13 (81%) patients, 2 years in 9 (56%), 3 years in 9 (56%), 4 years in 7 (44%), and 5 years in 5 (31%).

The indications for vitrectomy following tumour treatment were persistent vitreous haemorrhage in 10 eyes (63%), retinal detachment in 5 eyes (31%), and combined vitreous haemorrhage and retinal detachment in 1 eye (6%) (Figure 1). The macula was detached in five out of the six eyes with retinal detachments at the time of presentation. The overall mean interval from initial tumour treatment to vitrectomy was 5.8 months (range 10 days to 8.8 years). The vitrectomy surgery was performed by a consultant in 14 eyes and the vitreoretinal fellow in 2 eyes, and in all cases under general anaesthesia using a 20 or 23 gauge, 3 port pars plana technique. The median total follow-up time after the first vitrectomy was 4.0 years (range 9 months to 15 years). Details of the tumour treatment and the indications for vitrectomy for each patient are shown in Table 2.

For the purpose of subgroup analysis, we defined vitrectomy as early (within 6 months of primary tumour treatment) or late (after 6 months).

Early vitrectomy

Vitrectomy surgery was performed within 6 months of initial tumour treatment in 10 eyes (63%) and was indicated for persistent vitreous haemorrhage in 4 (40%), retinal detachment in 5 (50%), and combined vitreous haemorrhage and retinal detachment in 1 (10%). The mean tumour thickness at presentation was 6.8 mm (1.5–12.1 mm), and the mean maximum base dimension was 9.4 mm (5.9–14.3 mm). The majority of the tumours involved the ciliary body or were predominantly anterior to the equator (8 of the 10 eyes). Of the six eyes with retinal detachment, two had existing serous detachments at the time of diagnosis that failed to resolve following primary tumour treatment (Cases 15 and 16). The other four consisted of one rhegmatogenous detachment
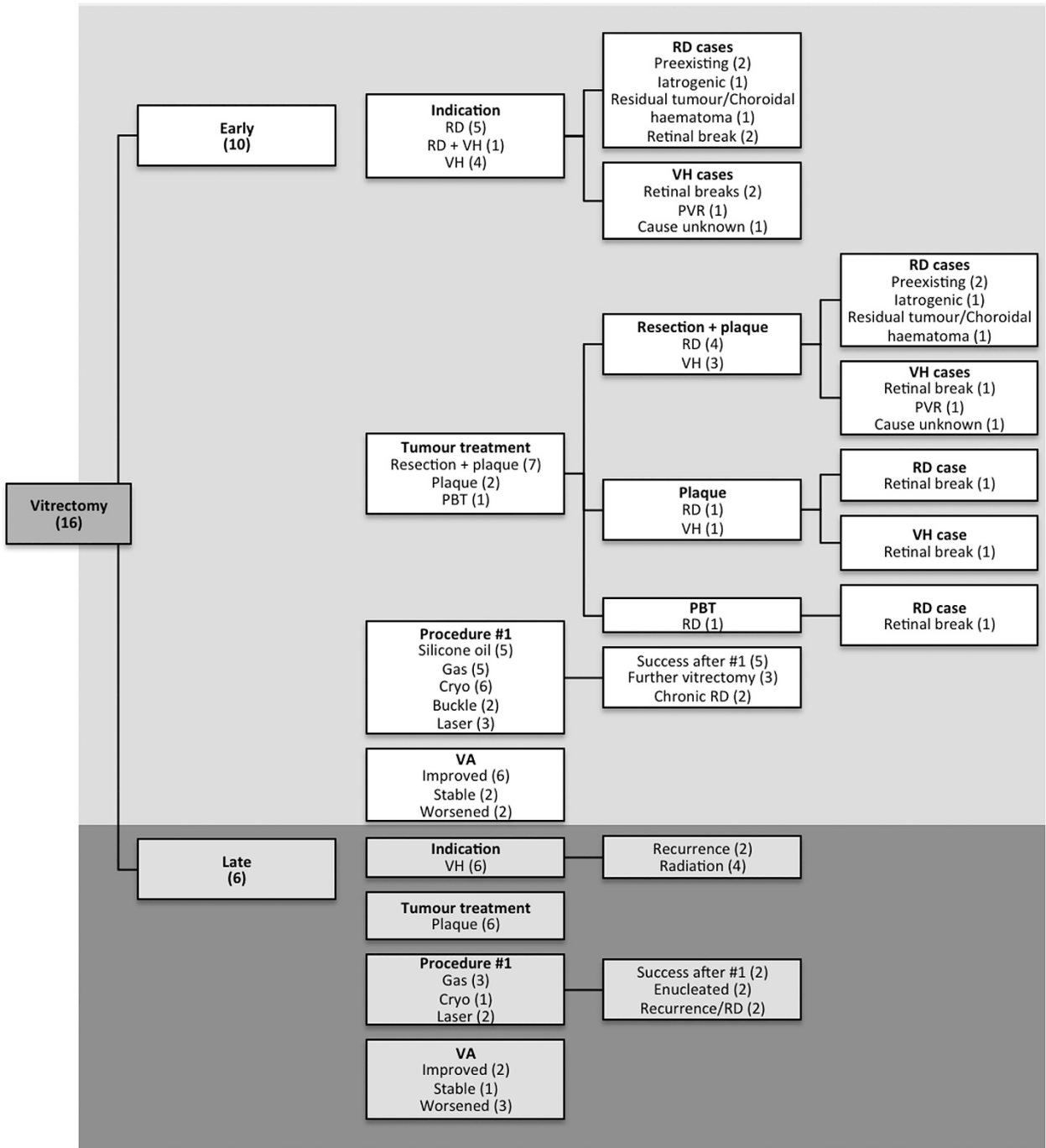

Figure 1 Flow diagram summarising the early and late indications for vitrectomy.

Table 2 Characteristics of patients and summary of outcomes

	Age	Gender	Eye	Tumour largest base (mm)	Tumour thickness (mm)	Tumour location	Tumour treatments	Time[a] (mo)	Indication	Initial VR surgery	Intraop findings	No. of VR surgeries	Anatomical success	Final vision	F/U time (mo)
1	36	F	R	11.3	8	Superior CB	Resection + plaque	5.9	VH	PPV	No breaks	1	Y	6/9 (imp)	81
2	52	F	L	10	9	Inferonasal C	Resection + plaque; Diode laser	2.0	RD	PPV, SO, partial endoresection	Coloboma edge residual tumour	2	Y	3/18 (imp)	22
3	23	F	R	7	5	Inferonasal CB	Resection + plaque	0.3	RD	PPV, gas, plomb	No breaks	1	Y	6/24 (imp)	164
4	63	F	L	8	5	Inferonasal C	Resection + plaque	3.3	VH	PPV, cryo, gas	Multiple breaks superior	3	Y	1/60 (imp)	51[b]
5	73	M	L	7.9	2.7	Inferotemporal C	Plaque	5.7	VH	PPV, cryo, laser, gas	Retinal hole temporal	1	Y	6/18 (imp)	8
6	75	M	R	5.9	1.5	Inferior juxtapapillary C	Plaque	0.4	RD	PPV, cryo, gas	Multiple breaks superior	1	Y	6/6 (imp)	18
7	57	M	L	14.3	7.4	Nasal CB	PBT	4.0	RD	PPV, cryo, SO	Retinal hole inferior	1	N	NPL (wor)	109
8	60	F	R	NA	NA	Superior C	Resection + plaque	3.0	VH	PPV, SO	PVR	1	Y	HM (same)	43[c]
9	56	M	R	9.9	5.5	Inferonasal amelanotic C	Plaque	99.2	VH	PPV, laser, gas		1	Y	6/5 (imp)	3
10	43	M	R	8	3.5	Inferior macula C	Plaque; Diode laser; PBT	105.1 (plaque),	VH	PPV		1	Y	6/18 (imp)	83
11	45	M	R	7.8	4	Superotemporal C	Plaque	17.3	VH	PPV	Active melanoma	1	N	EN	19
12	62	F	R	11.8	4.9	Superotemporal C	Plaque	35.4	VH	PPV		1	N	EN	4
13	56	F	L	6.8	4	Optic nerve head C	Plaque	105.2	VH	PPV, laser, gas	Subretinal haem	3	N	HM (wor)	20
14	42	M	R	10.3	4.2	Temporal C	Plaque	28.6	VH	PPV, cryo, retinectomy, gas	PVR	4	N	HM (wor)	46
15	71	M	L	7.8	10.1	Inferotemporal C with RD	Resection + plaque	2.6	RD	PPV, cryo, laser, plomb, SO	Coloboma edge subretinal fluid	2	N	6/60 (same)	135
16	54	M	R	12	12.1	Inferior amelanotic C with RD	Resection + plaque	1.0	RD + VH	PPV, cryo, SO	PVR, ?coloboma edge tear	1	N	NPL (wor)	53

Abbreviations: C, choroid; CB, ciliary body; cryo, cryotherapy; EN, enucleated; F, female; F/U time, follow-up time after first VR surgery; haem, haemorrhage; HM, hand movement; Imp, improve; Intraop, intra = operative; L, left; M, male; N, no; NA, not available; NPL, no perception of light; PBT, proton beam therapy; PPV, pars plana vitrectomy; R, right; RD, retinal detachment; Same, no change in visual acuity; SO, silicone oil; VH, vitreous haemorrhage; VR, vitreoretinal; Wor, worse; Y, yes. [a]Time interval from initial tumour treatment to VR surgery. [b]Followed up locally. [c]Deceased due to metastatic melanoma.

(Case 6), one serous detachment thought to relate to radiation-induced chorioretinal atrophy (Case 7), one serous detachment thought to relate to tumour recurrence (Cases 2), and one further exudative detachment (Case 3).

The majority of eyes requiring vitrectomy had undergone treatment with combined local resection and plaque brachytherapy, accounting for 7 out of 10 cases. In this subgroup, four were indicated for retinal detachment and three for vitreous haemorrhage. Two of the four retinal detachments were due to existing serous detachment (Cases 15 and 16), one was associated with iatrogenic retinal breaks at the edge of the resection site (Cases 3), and the fourth was an eye with postoperative choroidal haematoma and subsequent retinal detachment found to be associated with residual tumour (Case 2). Of the three cases of vitreous haemorrhage, one was associated with multiple retinal breaks (Case 4), one with proliferative vitreoretinopathy (PVR) (Case 8), and one of unknown cause (Case 1) (Table 2).

Of the three eyes requiring early vitrectomy that had not undergone local resection, two received Ru-106 plaque brachytherapy and one PBT. The indications for vitrectomy following brachytherapy were a dense vitreous haemorrhage (Case 5) and a rhegmatogenous retinal detachment with retinal breaks opposite to the location of the tumour (Case 6). The vitrectomy following PBT was for a retinal detachment associated with a round hole away from the tumour site (Case 7).

A single vitreoretinal procedure resulted in anatomical success in two cases of retinal detachment, and complete clearance in three cases of vitreous haemorrhage. However, three cases required multiple procedures, including one redetachment following removal of silicone oil requiring reintroduction of heavy liquid Densiron (Case 2), one redetachment (total) after gas and buckle requiring retinectomy and silicone oil (Case 4), and one persistent detachment after buckling who required

silicone oil and additional buckling (Case 15). A further two eyes had chronic, stable retinal detachments, one with PVR noted at the time of silicone oil removal (Case 7), and one with preexisting retinal detachment with silicone oil left *in situ* (Case 16). No further attempts at reattachment were undertaken in these cases. Subsequent cataract extraction was required in four eyes with or without simultaneous removal of silicone oil. Table 3 summarises the details of the surgery.

Following vitrectomy, visual acuities improved in 6 out of 10 eyes (60%), remained stable in 2 eyes, and deteriorated in 2 eyes (Figure 2). No eyes required enucleation, although three developed secondary glaucoma, one of which was rubeotic (a case of retinal detachment following PBT, Case 7). Two patients underwent surgery for strabismus. One patient (Case 16) required ongoing tumour surveillance using magnetic resonance imaging due to poor quality ultrasounds in the presence of silicone oil. One patient died of metastatic melanoma 4 years after first presentation with uveal melanoma (Case 8).

Late vitrectomy

Late vitrectomy was required in 6 eyes after a median of 5.6 years (1.4–8.8 years). Mean tumour thickness at presentation was 4.4 mm (3.5–5.5 mm) with a mean maximum base dimension of 9.1 mm (6.8–11.8 mm). All of the tumours in this group involved the posterior pole or were predominantly posterior to the equator. The initial indication for surgery was non-clearing vitreous haemorrhage in all cases, although three of the six were complicated by retinal detachments secondary to PVR. In all cases, the initial tumour treatment had been with plaque brachytherapy. The aetiology of the haemorrhage was tumour recurrence in two eyes and proliferative radiation retinopathy in four eyes. In the cases of

Table 3 Vitreoretinal procedures

	Early group			Late group			
	First VR surgery	Second VR surgery	Third VR surgery	First VR surgery	Second VR surgery	Third VR surgery	Fourth VR surgery
PPV	10	1		6	2		1
SO tamponade	5	1	1		2		1
Gas/air tamponade	5	1	1	3		1	
Densiron tamponade		1				1	
Cryotherapy	6	1	1	1			
Laser photocoagulation	3	2	1	2	1	1	
Buckle	2	2					
Partial endoresection	1						
Retinectomy		1	1			1	
Removal of silicone oil		4	2			1	
+ Phaco with IOL		3	1			1	

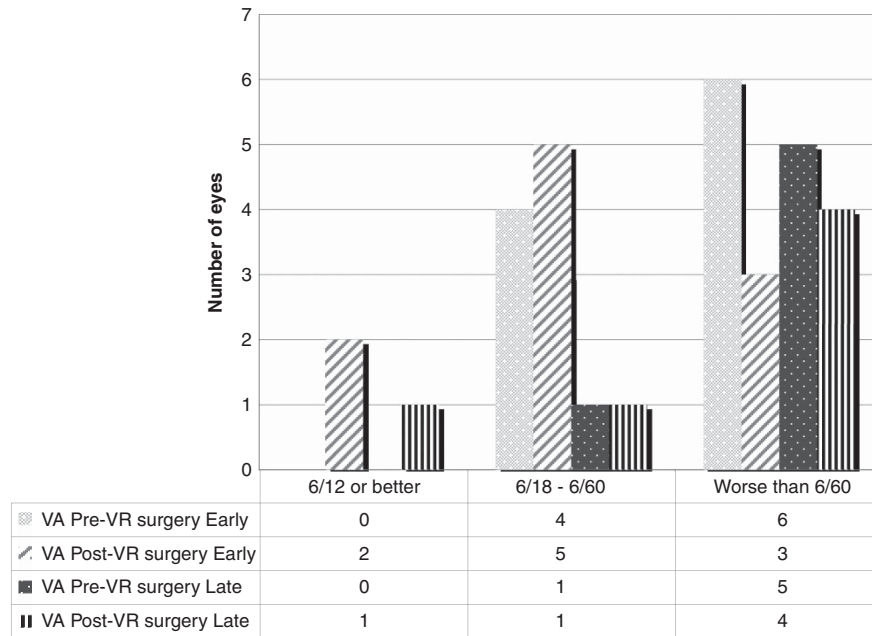|	6/12 or better	6/18 - 6/60	Worse than 6/60
▨ VA Pre-VR surgery Early	0	4	6
◪ VA Post-VR surgery Early	2	5	3
◼ VA Pre-VR surgery Late	0	1	5
‖ VA Post-VR surgery Late	1	1	4

Figure 2 Functional visual prognosis following VR surgery.

recurrence, one eye was eventually enucleated after failed retreatment with diode laser and PBT, and one eye developed recurrent vitreous haemorrhage and was enucleated after tumour recurrence was demonstrated on ultrasound. In the cases of proliferative radiation retinopathy, complete resolution of vitreous haemorrhage was achieved in two eyes, and of the others, one suffered a recurrent haemorrhage after 1 month followed by a retinal detachment after removal of silicone oil, and the other recurrent haemorrhage after 2 weeks associated with PVR and redetachment.

Visual acuities improved in 2 out of 6 eyes (33%) and deteriorated in 4 eyes (67%). Factors limiting vision where acuity deteriorated were radiation retinopathy (Case 13), tumour recurrence (Cases 11 and 12), and persisting retinal detachment (Case 14).

Statistical analysis

A statistically significant association was found between the need for early vitrectomy and undergoing local trans-scleral resection ($P = 0.011$) and for late vitrectomy having undergone plaque brachytherapy ($P = 0.007$). Pretreatment tumour height was found to be greater in the early vitrectomy group compared with the late group ($P = 0.038$), in the retinal detachment group compared with the vitreous haemorrhage group ($P = 0.033$), and in tumours predominantly anterior to the equator compared with those predominantly posterior to it ($P = 0.0001$). No other associations reached statistical significance, though

two associations may be of clinical significance: anatomical failure at first vitrectomy with silicone oil tamponade compared with anatomical success at first vitrectomy with gas tamponade ($P = 0.067$), and greater likelihood of achieving complete clearance of vitreous haemorrhage at first vitrectomy in the early group compared with complete clearance in the late group ($P = 0.076$).

Discussion

Vitreoretinal surgery has an important role to play in the management of the complications arising from globe-sparing treatments for uveal melanoma, with the main indications being the clearance of vitreous haemorrhage and repair of retinal detachments. To our knowledge this is the first study to compare the early and late indications for vitrectomy following these treatments.

In our cohort, the commonest indication for early vitrectomy was the development of retinal detachment following local resection (4 from 43 eyes (9.3%)). A large series of 156 trans-scleral local resections published by Damato *et al*[5] reported a rate of retinal detachment requiring vitrectomy of 16% (25 eyes), of which the majority were diagnosed within the first postoperative month. In this study, retinal detachment was attributed to iatrogenic retinal tears or to poor adhesion between the retina and sclera at the site of the surgical coloboma. Adjunctive Ru-106 plaque radiotherapy was administered to all eyes, as in our own group. There are, however, some

important differences in surgical technique between the two studies. All patients undergoing local resection in our service received a core vitrectomy with air tamponade, whereas Damato's patients had a core vitrectomy with the globe reformed with balanced salt solution. Cases with retinal breaks observed at the time of resection are initially monitored in our unit, with a secondary vitrectomy if required, but received immediate vitrectomy with silicone oil in the Damato series (accounting for 11 of the 25 (44%) of the vitrectomies performed).

In our cohort, early vitrectomy for retinal detachment was most commonly associated with larger tumours involving the ciliary body or which were predominantly anterior to the equator, and although Damato *et al*[5] found greater tumour thickness to be a risk factor for retinal detachment, no significant association with tumour location was reported in this series.

We only had a single vitrectomy for retinal detachment following Ru-106 plaque brachytherapy (a rate of 0.22%) —a superior macula-off rhegmatogenous detachment 2 days after plaque removal, with a break away from the site of plaque attachment. This contrasts with a 1.48% detachment rate following Ru-106 plaques in a series published by Beykin *et al*,[6] and in which the detachments tended to develop late (at a mean of 50.1 months post-brachytherapy, with the earliest at 3.5 months), all of which were assumed to relate to late exudative detachment, subretinal fibrosis, retinal thinning, or atrophic holes. The lower rates of vitrectomy for retinal detachment following both local resection and plaque brachytherapy in our series may reflect different case selection or different thresholds for vitrectomy. For example, a higher proportion of larger tumours may have undergone PBT and enucleation rather than local resection in our cohort, or we may have been more inclined to manage localised, stable detachments by observation rather than vitrectomy.

Vitrectomy following primary PBT is uncommon. In our series, we had 1 case of early detachment (0.9%) following PBT, a round hole away from the tumour site, with a similarly low rate of 2 from 1005 eyes (0.2%) reported by Tran *et al*.[7] Of those in the Tran series, one was a rhegmatogenous detachment, and the other a serous detachment associated with vitreous haemorrhage. The timing of vitrectomy was not specified.

The commonest indication for vitrectomy for vitreous haemorrhage in our cohort was as a late complication of plaque brachytherapy (1.57%). This is consistent with previously published rates of 1.2% (47 from 3841 eyes) reported by Bansal *et al*[8] and 2.0% (74 of 3707 eyes) by Bianciotto *et al*,[9] both following application of Iodine-125 plaques. In keeping with our findings, existing literature recognises that vitrectomy for vitreous haemorrhage

following plaque brachytherapy is usually a late phenomenon[8,10] and commonly associated with radiation retinopathy.[9] We had no cases of vitrectomy for vitreous haemorrhage following primary PBT, although Tran *et al*[7] report a rate of 2.0% after an average of 21 months, and with vitreous haemorrhage more common with more posteriorly located tumours.

Reviewing the outcomes from vitrectomy for retinal detachment, Damato *et al*[5] report anatomical success from retinal detachment repair after trans-scleral local resection in 84% of cases and at the first attempt in 72%. In our series, 50% achieved anatomical success, and at the first attempt in 33%, although this is likely to reflect the very different approaches to managing retinal detachment adopted by our respective services. As previously discussed, Damato *et al*[5] performed prophylactic vitrectomy with oil tamponade at the time of local resection in cases where retinal detachment was identified, whereas all our patients received a core vitrectomy with air tamponade regardless of the retinal status. We then performed a secondary vitrectomy with gas or silicone oil in those cases with persistent detachment, and in this group the reattachment rate from vitrectomy with gas tamponade was higher than that achieved with oil tamponade. However, this is likely to reflect the fact that more complex detachments were treated with oil, and our study is not sufficiently powered to evaluate the role of silicone oil in retinal reattachment. Visual outcomes are generally poor, with only 2/25 eyes achieving an acuity of 6/60 of better in the series by Damato *et al*[5] and 2/4 eyes achieving 6/60 or better in our own study. Hence although vitrectomy procedures for retinal detachment following local resection may increase the eye retention rate, they rarely result in good vision.

In contrast to local resection, rates of anatomical success and improved visual acuity following retinal detachment repair after plaque brachytherapy tend to be much higher. In the series by Beykin *et al*[6] of late retinal detachment repair after Ru-106 plaque, all eyes achieved anatomical success at the first attempt using silicone oil tamponade,[6] with significant improvements in visual acuity to 6/60 or better in 4/7 eyes. Another study of microincisional vitrectomy performed in a large series of 102 eyes with retinal detachment after Iodine-125 brachytherapy found that 6.9% required a second surgical procedure and that 2.9% had persisting exudative retinal detachment but with significant improvements in visual acuity overall.[11] Our single case of retinal detachment requiring early vitrectomy following Ru-106 plaque application achieved anatomical success and visual acuity of 6/6 at the first attempt using gas tamponade.

Two studies report successful vitrectomy for clearance of vitreous haemorrhage following Iodine-125 brachytherapy at rates of 53/74 (72%)[9] and 35/47 (74%),[8]

but the visual outcomes were poor with 34/47 (72%)[8] of eyes achieving an acuity of 6/60 or worse, attributed to radiation retinopathy. In contrast, our rate of complete clearance of vitreous haemorrhage was lower at 2/6 (33%) but with similar final visual acuity of 6/60 or worse in 4/6 (67%). Previous studies have reported good visual outcomes following vitrectomy for vitreous haemorrhage or retinal detachment after PBT,[7] but unfortunately our single patient with an early detachment after PBT had a failed retinal detachment repair, and no further attempts were deemed appropriate.

Tumour recurrence is recognised as a late phenomenon in a proportion of eyes treated solely with Ru-106 plaque brachytherapy.[12–14] We encountered two cases in which tumour activity became evident by direct observation during vitrectomy for non-clearing vitreous haemorrhage. These were treated at the time with endolaser, but both cases ultimately required enucleation.

In our study, all late vitrectomies were indicated for vitreous haemorrhage following plaque brachytherapy. However, elsewhere in the literature reports of late detachments following plaque brachytherapy and PBT are described.[6,7,11] In these cases, the extent of vitreoretinal adhesions seems to be critical, and as these adhesions tend to progress over time early retinal detachment repair is theoretically preferable and may be associated with better visual outcomes.[5,7,11] In addition to retinal detachments due to vitreoretinal traction, other mechanisms such as proliferative vitreoretinopathy,[5] poor adhesion between the retina and sclera at the site of surgical coloboma,[5] and edge recurrence are described.[15] A single case of intraocular dissemination of melanoma cells had been reported by Foster et al[10] 54 months following vitrectomy in an irradiated uveal melanoma. However, in common with other studies we found vitrectomy to be safe even following multiple procedures, with no cases of intraocular dissemination.

A weakness of our study, as is often the case in the analysis of relatively rare complications, are the small numbers and retrospective nature of the series, placing limitations on the conclusions that can be drawn. Furthermore, clinical practice varies widely from unit to unit in this field, and direct comparison of vitrectomy rates and visual outcomes between studies should therefore be interpreted with caution. This is also the case for the rate of primary enucleation of 15% (129 eyes) in our cohort, as it is difficult to know whether those cases might have undergone globe-sparing treatments (including vitrectomy) in other units. Nevertheless, we have the advantage of minimal follow-up bias in our centre, with all patients except one—who was seen locally for reasons of geography once the vitreoretinal status was stable—receiving all treatment and follow-up in the

SOOS. This is particularly beneficial in allowing us to be confident in identifying all cases requiring vitrectomy for late complications.

Conclusion

There is an important role for vitreoretinal surgery in the management of the complications arising from globe-sparing surgery for choroidal melanoma, and this surgery is often challenging with a guarded visual prognosis.[16] As might be expected, larger tumours anterior to the equator or involving the ciliary body tended to be those which were suitable for local resection, and it was also this group who tended to require early vitrectomy for retinal detachment. We have established a statistically significant association between local resection and the need for early vitrectomy, and it is likely that this in turn accounts for the statistically significant association between larger tumours and early vitrectomy. Late vitrectomy for vitreous haemorrhage was associated with tumour recurrence or radiation retinopathy following Ru-106 plaque brachytherapy for more posterior tumours. Multiple vitreoretinal procedures were often required to achieve anatomical success. Overall, the majority of patients undergoing vitrectomy gained or maintained vision, with better outcomes in the early vitrectomy group.

Summary

What was known before
- Vitrectomy is a safe procedure which has an important role in managing retinal detachment and vitreous haemorrhage arising after globe-sparing treatment of uveal melanoma.

What this study adds
- Early vitrectomy is most commonly indicated for retinal detachment following local resection, and late vitrectomy for vitreous haemorrhage following plaque brachytherapy. Larger tumours located anterior to the equator were more likely to undergo local resection, associated with a higher incidence of retinal detachment and early vitrectomy.

Conflict of interest

The authors declare no conflict of interest.

References

1   Colloborative Ocular Melanoma Study (COMS) Group. The COMS randomized trial of iodine 125 brachytherapy for choroidal melanoma: V. Twelve-year mortality rates and prognostic factors: COMS report No. 28. *Arch Ophthalmol* 2006; **124**(12): 1684–1693.

2 Houston SKS, Ardila ML, Markoe A, Murray TG. When to consider vitrectomy in eyes with posterior uveal melanoma. *Retinal Physician* 2012; **9**: 24–28.

3 http://www.scotlandscensus.gov.uk/en/censusresults/rel1asb.html#5. Accessed 15 December 2013.

4 http://www.graphpad.com/quickcalcs/contingency1.cfm. Accessed 18 February 2014.

5 Damato B, Groenewald CP, McGalliard JN, Wong D. Rhegmatogenous retinal detachment after transscleral local resection of choroidal melanoma. *Ophthalmology* 2002; **109**: 2137–2143.

6 Beykin G, Pe'er J, Hemo Y, Frenkel S, Chowers I. Pars plana vitrectomy to repair retinal detachment following brachytherapy for uveal melanoma. *Br J Ophthalmol* 2013; **97**: 1534–1537.

7 Tran BK, Schalenbourg A, Bovey E, Zografos L, Wolfensberger TJ. Role of vitreoretinal surgery in maximizing treatment outcome following complications after proton therapy for uveal melanoma. *Retina* 2013; **33**: 1777–1783.

8 Bansal AS, Bianciotto CG, Maguire JI, Regillo CD, Shields JA, Shields CL. Safety of pars plana vitrectomy in eyes with plaque-irradiated posterior uveal melanoma. *Arch Ophthalmol* 2012; **130**(10): 1285–1290.

9 Bianciotto C, Shields CL, Pirondini C, Mashayekhi A, Furuta M, Shields JA. Vitreous haemorrhage after plaque radiotherapy for uveal melanoma. *Retina* 2012; **32**: 1156–1164.

10 Foster WJ, Harbour JW, Holekamp NM, Shah GK, Thomas MA. Pars plana vitrectomy in eyes containing a treated posterior uveal melanoma. *Am J Ophthalmol* 2003; **136**: 471–476.

11 Lonngi M, Houston SK, Murray TG, Sisk RA, Decatur CL, Cavalcante M *et al.* Microincisional vitrectomy for retinal detachment in I-125 brachytherapy-treated patients with posterior uveal malignant melanoma. *Clin Ophthalmol* 2013; **7**: 427–435.

12 Wilson MW, Hungerford JL. Comparison of episcleral plaque and proton beam radiation therapy for the treatment of choroidal melanoma. *Ophthalmology* 1999; **106**: 1579–1587.

13 Papageorgiou LI, Cohen VML, Bunce C, Kinsella M, Hungerford JL. Predicting local control of choroidal melanomas following 106Ru plaque brachytherapy. *Br J Ophthalmol* 2011; **95**: 166–170.

14 Lommatzsch PK, Werschnik C, Schuster E. Long-term follow-up of Ru-106/Rh-106 brachytherapy for posterior uveal melanoma. *Graefes Arch Clin Exp Ophthalmol* 2000; **238**: 129–137.

15 Hungerford JL. Current trends in the treatment of ocular melanoma by radiotherapy. *Clin Experiment Ophthalmol* 2003; **31**(1): 8–13.

16 Shields JA, Shields CL, Donoso LA. Management of posterior uveal melanoma. *Surv Ophthalmol* 1991; **36**: 161–195.