Refractive change following pseudophakic vitrectomy: a retrospective review

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Abstract

Background: To assess the occurrence and magnitude of refractive change in pseudophakic eyes undergoing pars plana vitrectomy without scleral buckling and to investigate possible aetiological factors.

Methods: Retrospective case note review of pseudophakic eyes undergoing pars plana vitrectomy for a variety of vitreo-retinal conditions over a three-year period. Anterior chamber depth was measured before and after vitrectomy surgery in 32 eyes. Thirty-seven fellow pseudophakic eyes were used as controls.

Results: Eighty-seven eyes (84 patients) were included in the study. Mean spherical equivalent refraction prior to vitrectomy was –0.2 dioptres, which changed to a mean of -0.65 dioptres postoperatively (SD of refractive change +/- 0.6 , range 0.75 to –2.13 dioptres) (p<0.001). Sixty-one of the 87(70%) eyes experienced a myopic shift and 45(52%) eyes had a myopic shift of –0.5 dioptres or more. Mean fellow eye refraction was –0.14 dioptres preoperatively and –0.12 dioptres postoperatively (p=0.51)(n=37) Mean anterior chamber depth preoperatively was 3.29mm and postoperatively 3.27mm (p=0.87) (n=32) and there was no correlation between any pre, intra and postoperative factors examined and the refractive change observed.

Conclusion: Significant persistent refractive changes occur in some pseudophakic patients undergoing pars plana vitrectomy. The mean change observed was a small myopic shift but the range was large. The aetiology of the refractive change is uncertain.
Background

The refractive index of the vitreous, being 99% water, is virtually identical to that of aqueous, and hence vitrectomy, without scleral buckling, in pseudophakic eyes is not thought conventionally to effect refraction. Corneal topographic changes have been noted after vitrectomy, but corneal shape returns to pre operative levels within three months. We recently had experience of a pseudophakic patient who had a significant myopic shift in his refraction after vitrectomy, for macular on retinal detachment (See Box 1). We decided therefore to investigate refractive status pre and post vitrectomy in a series of pseudophakic patients undergoing vitrectomy and examine any factors that might explain and predict refractive change.

Box 1

A 32-year-old man underwent clear lens extraction with phacoemulsification for the correction of high myopia after problems with contact lens intolerance. Postoperatively he was pleased with the result and achieved acuity in his right eye of 6/18 unaided which improved to 6/6 with a correction of +1/+1 at 90°. He maintained stable vision but two years following surgery he presented with a two-day history of a visual floaters and an infero-nasal field defect and was found to have a supero-temporal retinal detachment with the macula still just attached. Vitrectomy surgery was carried out the same day with cryotherapy to a single superior horseshoe tear and SF6 gas tamponade. On postoperative review his retina was attached and he was pleased with his unaided vision, which had improved to 6/9. Three months following surgery his vision was stable.
with a refractive correction of 0/+1 at 90° which remained unchanged over a follow up period of 24 months.

Methods

We reviewed the case notes of pseudophakic patients undergoing three-port pars plana vitrectomy for a variety of vitreo-retinal conditions over a three-year period. The following criteria were essential for inclusion:

1) An inter-operative period of greater than four months between phacoemulsification and vitrectomy to allow refractive stabilisation.

2) Availability of refractive data obtained three months post cataract surgery and three months post vitrectomy.

3) Details of Intraocular lens (IOL) power and type documented at the time of the original cataract extraction.

The following data was recorded from the notes: Date of cataract surgery, type and power of intraocular lens implant used, axial length prior to vitrectomy, indication for vitrectomy, time between vitrectomy and cataract extraction, vitreo-retinal procedure undertaken, including type of tamponade agent used, refraction before and after vitrectomy and the occurrence of any intra or postoperative problems.

Anterior chamber depth was measured in 32 patients one day prior to, and four months following vitrectomy using the Zeiss IOL Master. Measurements were taken with the patient seated in an upright position under standardised lighting conditions and an
average of 10 readings was used. Control refractive data was obtained on 37 pseudophakic fellow eyes.

Statistical analysis was carried out to assess the degree of refractive change from pre to post vitrectomy, and to determine any correlation of refractive change observed and a variety of pre, intra and post operative factors.

All the vitrectomy procedures were carried out by one surgeon using a 20-gauge three-port pars plana technique with self-sealing scleral tunnels created perpendicular to the limbus.

Statistical analysis was carried out using SPSS for windows. Paired t tests were used to assess changes in refraction and anterior chamber depth before and after vitrectomy. Pearson’s correlation coefficient and Spearman’s rho were used to assess the effect of a variety of quantitative and qualitative factors respectively on refractive change with vitrectomy surgery. The effect of raised intraocular pressure and capsulotomy on any refractive change with vitrectomy was assessed using paired t tests.

Results

Eighty-seven eyes of 84 patients were included. Forty-eight were female and 39 male. The mean age was 65 years old with a range of 38-84 years.

Indications for vitrectomy surgery were macula on retinal detachment in 17(19%) of patients, macular off retinal detachment in 15(17%), macular pucker in 15(17%), macular
hole in 15(17%), proliferative diabetic retinopathy in 14(16%), and miscellaneous in 
11(13%).

Tamponade with air or SF6 was used in 24(28%) and C3F8 in 34(39%).

The mean time from cataract surgery to vitrectomy surgery was 39 months (range 4-149 
months).

Four groups of intraocular lens type were noted: 52(60%) were folding three piece 
arylic IOLs, 10(11%) were folding acrylic one piece lenses, 6(7%) were silicone plate 
enses and 18(21%) were rigid Polymethylmethacrylate (PMMA) lenses.

IOL power ranged from 2 to 33 dioptres (mean 20.4 dioptres). Axial length ranged from 
19.50mm to 34.01mm (mean 23.71mm).

Five eyes experienced a rise in intraocular pressure immediately postoperatively to 
greater than 35mm hg. All were successfully treated and pressure was controlled within 
24hours. Thirty-two eyes had a surgical capsulotomy performed during the vitrectomy 
procedure and 12 eyes had a prior Yag laser capsulotomy.

Refraction prior to vitrectomy ranged from –2.75 to +2.6 dioptres spherical equivalent 
with a mean of –0.2 dioptres. Postoperatively this changed to a mean spherical 
equivalent of –0.65 dioptres representing a significant change of –0.45 dioptres 
(standard deviation +/- 0.6, range 0.75 to –2.13 dioptres) (p<0.001). Sixty-one of the 
87(70%) eyes experienced a myopic shift and 45(52%) eyes had a myopic shift of –0.5 
dioptres or more. Mean cylinder was 0.55 at 103 degrees preoperatively and 0.80
dioptres at 115 postoperatively (p=0.38). Mean anterior chamber depth preoperatively was 3.29mm and postoperatively 3.27mm (p=0.87) (n=32)

Mean fellow eye refraction was –0.14 dioptres preoperatively and –0.12 dioptres postoperatively (p=0.51)(n=37)

We found no relationship between any of the above factors and the change observed in refraction with vitrectomy (Table 1)
<table>
<thead>
<tr>
<th>Table 1</th>
<th>Pearson’s correlation coefficient</th>
<th>Spearman’s rho</th>
<th>Paired T test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.02 (p=0.85)</td>
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<td></td>
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<tr>
<td>Time from phacoemulsification to vitrectomy</td>
<td>0.18 (p=0.14)</td>
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<td></td>
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<tr>
<td>IOL power</td>
<td>0.09 (p=0.46)</td>
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<td></td>
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<tr>
<td>Anterior chamber depth preoperatively</td>
<td>0.17 (p=0.36)</td>
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<tr>
<td>Change in anterior chamber depth</td>
<td>-0.07 (p=0.27)</td>
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<tr>
<td>Preoperative refraction</td>
<td>-0.21 (p=0.25)</td>
<td></td>
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<tr>
<td>Indication for vitrectomy</td>
<td>-0.009 (p=0.94)</td>
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<td>Tamponade use</td>
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<td>IOL type</td>
<td>0.045 (p=0.71)</td>
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<td>Axial length</td>
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<tr>
<td>Raised IOP postoperatively</td>
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<td></td>
<td>p=0.96</td>
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<tr>
<td>Presence of capsulotomy</td>
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<td>p=0.57</td>
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</table>
We noticed a small but significant myopic shift in refraction of –0.45 dioptres four months following vitrectomy in this series of pseudophakic patients. The degree of refractive change was variable ranging from +0.75 to –2.13 dioptres but 52% of eyes experienced –0.5 dioptres of myopic shift or more. Other authors have also noticed similar changes. Kumagai et al found a mean refractive change of –0.3 dioptres at one month postoperatively that became positive on more prolonged follow up [1]. Sharma in a study comparing scleral buckling surgery to vitrectomy in the treatment of pseudophakic retinal detachment, found a mean change of –0.84 dioptres with vitrectomy surgery alone [2]. Campo et al found a –0.15 dioptre change after vitrectomy surgery again in a study of vitrectomy for pseudophakic retinal detachment [3]. The exact time point when refractive change was assessed was not clear in the latter two papers.

There are a number of possible explanations for the myopic shift that we found. Firstly, it is possible that vitrectomy, especially if combined with gas tamponade, could result in anterior movement in IOL position, resulting in a myopic shift especially in cases of a sulcus fixated IOL, flexible IOL or in cases with a large capsulorhexis. This has been proposed as a possible explanation for the small myopic shift seen after combined phacovitrectomy surgery with gas tamponade [4] and by Sharma et al. for the myopic shift they observed following vitrectomy for retinal detachment [2]. Anterior chamber depth has been shown to vary in the first three months post-operatively following cataract surgery with refractive change [5], hence we specifically excluded patients having vitrectomy surgery within four months of cataract surgery.
We assessed anterior chamber depth pre and postoperatively in 32 patients, however we did not find any significant change in anterior chamber depth and there was no correlation between anterior chamber depth pre-operatively and the change in postoperative refraction. Furthermore there are a number of other findings that suggest that IOL position change was not causing the myopic shift we have observed. We found no correlation between postoperative tamponade and refractive change, IOL type, time between phaco surgery and vitrectomy surgery, IOL power or axial length. If IOL position change was causing the myopic shift, then correlation between these may have been expected.

Vitreous has a refractive index of 1.336, which is identical to that of aqueous, and so we do not think that vitreous removal resulted in any significant refractive change.

Posterior capsulotomies were performed intra operatively during vitrectomy in 32 of the 87 eyes and twelve eyes had pre-existing laser capsulotomies. However no myopic shift has been associated with capsulotomy in non vitrectomised eyes [6,7] and furthermore, there was no correlation between the occurrence of capsulotomy and the myopic shift we observed.

Kumagai et al noted that refractive change they observed after vitrectomy surgery at six months was inversely correlated with pre-operative refractions, in that eyes with greater than 1.5 dioptres of myopia preoperatively experienced a hypermetropic shift in refraction and eyes with less than 1.5 dioptres of myopia experienced a negative shift in refraction¹. It is not clear in their paper if preoperative refraction was measured prior to cataract surgery or following [8]. The vast majority of eyes in our study had a near
emmetropic pseudophakic refraction prior to vitrectomy and we did not find a correlation between preoperative refraction and the refractive change.

Three-port pars plana vitrectomy has been associated with a steepening of the central cornea in the immediate postoperative period as summarised by Randlemann [9]. We found no significant astigmatic changes following pseudophakic vitrectomy as noted by other authors. Refractions were carried out at least 3 months post-operatively, by which time any astigmatic changes associated with vitrectomy would have resolved [10,11].

A possible explanation for the myopic shift seen during phacovitrectomy surgery [4,12] is that a falsely short axial length is measured when macular thickening is present. Potentially this could also account for a refractive change in pseudophakic eyes with macular pathology after correction of the abnormality with vitrectomy surgery. However, this is not the explanation in our cases as in all but seven cases, the pre-operative refraction predated the evolution of the retinal pathology corrected by the vitrectomy surgery.

We did not measure axial length pre and post-operatively, however it is possible that a true increase in axial length could have caused the myopic shift, possibly with post-operative stretching of sclerostomies associated with increased intra ocular pressure. Bratzikos et al found a small but significant increase in axial length of 0.1mm in a series of eyes undergoing vitrectomy without scleral buckling as compared to a study group undergoing scleral buckling surgery alone [13]. A change in axial length of this order could produce the refractive changes we have seen [14]. Jeoung et al. recently reported the results of a prospective study investigating factors influencing the refractive outcome
of patients undergoing combined phacovitrectomy. Eyes with axial lengths greater than 24.5mm experienced a myopic shift in achieved refraction from predicted of the order of –0.40 dioptres. They observed an apparent increase in axial length in these eyes and postulated that this may be a true increase in axial length associated with scleral stretching or thinning [15]. To assess whether an increase in axial length could have been an explanation for the myopic shift observed in this study we tested for any relationship between axial lengths, increased intraocular pressures immediately post operatively as well as age and refractive change. There were five eyes in this series that had significant intra ocular pressure raise post operatively however, none of these eyes had significant myopic shifts. Furthermore, there was no correlation between axial length pre operatively and age nor axial length and myopic shift. We could therefore find no evidence to support the hypothesis that axial length changes caused the myopic shift observed but this remains a possibility.

In conclusion significant persistent refractive changes occur in some pseudophakic patients undergoing vitrectomy procedures and it is important for clinicians to be aware of this possibility and be able to counsel patients appropriately. The mean change we observed was a small myopic shift but the range was large. We were unable to clearly define the aetiology of the refractive change or identify any risk factors for its occurrence.

Competing interests
The authors declare that they have no competing interests.
Authors’ contributions

SB carried out the literature review, data collection and formatting and drafted the manuscript. JN assisted in data collection and literature review. DS conceived of the study, participated in its design, performed the statistical analysis and helped draft the final manuscript.

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None

References


