Eye (2011) 25, 1202–1206

www.nature.com/eye

CLINICAL STUDY

Strabismus following retinal detachment repair: a comparison between scleral buckling and vitrectomy procedures

SA Kasbekar, V Wong, J Young, T Stappler and JM Durnian

Abstract

Purpose **We conducted a study to investigate: (1) deviations caused by retinal detachment (RD) repair; (2) correlation between visual acuity and the number of surgeries to deviation size; and (3) differences between deviations following scleral buckling (SB) and pars plana vitrectomy (PPV).**
Methods **A retrospective analysis of patients with persistent binocular diplopia following RD repair. Magnitude of manifest deviation (|dev|) in the primary position (PP) and position of greatest deviation (maxDev) was calculated. LogMAR acuity and number of previous vitreoretinal procedures were correlated to |dev| in both PP and maxDev. Manifest |dev| were compared between SB and PPV groups.**
Results **Twenty-five patients were identified. The median |dev| was 7 prism diopters (PD) in PP and 17 PD in maxDev. We found no association between number of surgeries or VA with |dev| in either the PP ($r=-0.18$ and $r=0.08$) or maxDev ($r=-0.26$ and $r=-0.05$). Twelve patients underwent PPV: median |dev| in PP 6 PD and maxDev 9 PD. In the SB group: median |dev| in PP 8 PD and in maxDev 22 PD. |dev| in PP showed no significant differences between PPV and SB ($U=63$, $P=0.41$); however, |dev| in maxDev, showed that SB have significantly greater deviations ($U=36.0$, $P=0.02$).**
Conclusion **We report the largest cohort of patients with symptomatic ocular motility defects following PPV. We show no association between VA or number of procedures to strabismus magnitude. Ocular deviations in maxDev are significantly greater after SB procedures.**

Eye (2011) **25,** 1202–1206; doi:10.1038/eye.2011.152; published online 24 June 2011

Keywords: strabismus; ocular motility; vitrectomy; scleral buckle

St Paul's Eye Unit, Royal Liverpool and Broadgreen NHS Trust, Royal Liverpool University Hospital, Liverpool, UK

Correspondence: J Durnian, St Paul's Eye Unit, Royal Liverpool and Broadgreen NHS Trust, Royal Liverpool University Hospital, Prescot Street, Liverpool L7 8XP, UK
Tel: +44 (0) 151 706 3992.
E-mail: jon.durnian@rlbuht.nhs.uk

Received: 15 March 2011
Accepted in revised form: 3 May 2011
Published online: 24 June 2011

Introduction

Vitreoretinal (VR) procedures are a recognised cause of secondary strabismus, being described since the 1950s. Most studies are retrospective and concerned with strabismus following scleral buckling (SB) repair of retinal detachments (RD). The reported incidence of post-operative diplopia varies between 3–14% in retrospective, and 73% in prospective studies,[1–7] being highest during the immediate post-operative period, and often transient when the vision is good.[3] The strabismus is reported greater with multiple VR procedures, encircling buckling elements rather than sectoral explants, and increasing number of muscles the explant is in direct contact with.[2,5–8] The strabismus has been attributed to several mechanisms including globe distortion, fibrotic adhesions, mass effect on muscle pulleys, the effects of local anaesthetic (LA), and sensory disturbance. Macula off RD and reduced postoperative visual acuity (VA) are associated with poorer outcomes for binocular vision.[9]

Some authors have advocated pars plana vitrectomy (PPV) as an alternative surgical option in selected RD patients, partly given the incidence of post-operative strabismus after SB

procedures.[7] Conflicting reports show that PPV has either no effect on motility or a similar effect to external buckling.[10,11]

We conducted a retrospective study of patients treated for persistent diplopia after RD surgery over a 2-year period to ascertain:

1. The magnitude of ocular deviations in patients reporting diplopia following RD surgery.
2. Any correlation between VA or the number of previous interventions to the magnitude of deviation.
3. Any differences in the magnitude of deviation following SB procedures and PPV.

Patients and methods

A retrospective review of all patients with symptomatic persistent diplopia following RD surgery between January 2007 and December 2008 was conducted. Patients were identified from a departmental database. Inclusion criteria were as follows: successful RD repair (success defined as retinal re-apposition with no re-detachment over the follow-up period); persistent binocular diplopia present at 2 months following RD surgery; age 16 years or over; and complete ophthalmological and orthoptic case notes available. Exclusion criteria was limited to those under the age of 16, incomplete case records, and resolution of binocular diplopia within 2 months of RD repair.

Basic patient demographics were recorded, along with the details of the RD and subsequent repair. The RD was assigned as 'macula on' or 'macula off' by the examining ophthalmologist before RD repair. The cohort was analysed as a whole, and then stratified based on the type of RD surgery, PPV or SB. VA was converted from Snellens acuity into logMAR acuity for statistical analysis.

All orthoptic measurements were taken from the latest orthoptic report. Measurements of manifest ocular deviation were measured using the simultaneous prism cover test where VA permitted, or prism light reflex test if the fixation was not possible. The horizontal (dev_h) and vertical (dev_v) deviations were analysed in both the primary position (PP) and the gaze position, where magnitude of deviation was the greatest (maxDev).

Ethical approval was not required for this study, but approval was obtained from the Information and Audit department of the Royal Liverpool University Hospital. The research was performed in compliance with the tenets of the Declaration of Helsinki.

Statistical analysis

The dev_h and dev_V ocular deviations measured in PD were converted to vectors ($|dev|$), allowing analysis of the combined defect: $|dev| = \sqrt{(dev_h^2 + dev_v^2)}$ as per mathematical convention.[12] LogMAR VA and number of previous VR procedures were correlated to $|dev|$ in both the PP and maxDev using non-liner regression. Magnitude of ($|dev|$) in the PP and maxDev were compared between the SB and PPV groups, using the Mann–Whitney *U*-test. Results were analysed using SPSS 18.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was regarded as $P<0.05$.

Results

Thirty-eight consecutive patients reporting troublesome diplopia following RD surgery between January 2007 and December 2008 were identified; complete data was available for 25 patients. The mean age of the patients was 65 (range 21–86), and the female to male ratio was 2 : 3. In all cases, diplopia was binocular and no alternative explanation for diplopia such as macular translocation was documented by the examining ophthalmologist. Only one patient had a pre-existing ocular motility defect, a resolved Abducens nerve paresis. The median time between the last RD surgery and orthoptic assessment was 6 months (range 2–39 months). Thirteen of the 25 patients suffered a macula off detachment. The mean number of VR procedures undertaken was 1.4 (SD 0.64). Median VA was 0.3. The median $|dev|$ for all patients in PP was 7 prism diopters (PD), and in maxDev, 17 PD. Regression analysis shows no significant association between either number of previous surgeries or VA with $|dev|$ in either the PP ($r=-0.18$ and $r=0.08$, respectively) or in the area of maximal deviation ($r=-0.26$ and $r=-0.05$, respectively).

Twelve patients, comprising eight men and four women with a median age of 72, underwent PPV (Table 1). Nine of the 12 patients (75%) had previous 'macula-off' RDs. None of these cases had previous SB procedures. The final VR surgery undertaken was performed under LA in 11 cases, and under general anaesthetic (GA) in one. The median VA following successful detachment repair was 0.48. The median $|dev|$ in PP was 6 PD, and in maxDev, 9 PD. Among the patients who underwent PPV, nine patients had combined dev_h and dev_v and three patients had with either dev_h or dev_v in the affected field of gaze. Eleven PPV patients were managed with prisms to overcome their diplopia, and one patient underwent strabismus surgery (inferior oblique myectomy) to improve ocular alignment.

Thirteen patients, comprising seven men and six women with a median age of 61, underwent SB procedures (Table 2). Five patients required circumferential buckles and eight segmental explants.

Table 1 Patient characteristics: post-operatively following PPV RD repair

Case no	*Macula*	*logMAR*	*RD surgeries*	*LA/ GA*[a]	*|dev| PP (PD)*	*Max|dev| (PD)*
1	Off	0.48	1	GA	8	20
2	Off	0.18	1	LA	0	2
3	Off	0.3	1	LA	6	7
4	Off	0.3	1	LA	6	8
5	Off	0.78	2	LA	10	20
6	Off	0.1	2	LA	13	17
7	On	0.18	3	LA	3	6
8	On	0.48	1	LA	10	10
9	Off	0.6	2	LA	14	20
10	On	0.48	1	LA	4	6
11	Off	0.6	2	LA	6	18
12	Off	1.8	3	LA	3	3

Abbreviations: |dev| PP, magnitude of deciation in the primary position; GA, general anaesthetic; LA, local anaesthetic; Max|dev|, maximum deviation recorded in any position; PD, prism diopters; RD, retinal detachment.
[a]Anaesthetic used at the patients' final VR procedure.

Table 2 Patient characteristics: post-operatively following scleral buckle retinal detachment repair

Case no	*Macula*	*logMAR*	*RD surgeries*	*LA/ GA*[a]	*|dev| PP (PD)*	*Max|dev| (PD)*
1	On	−0.18	1	GA	5	5
2	On	0.1	2	LA	4	15
3	Off	0.48	1	N/R	0	10
4	On	0.1	1	N/R	2	9
5	On	0.3	1	GA	7	18
6	On	0.18	1	LA	22	22
7	On	−0.08	1	GA	8	35
8	On	0.18	1	N/R	3	10
9	On	0.3	1	LA	11	33
10	Off	0.6	1	N/R	11	26
11	Off	0.1	1	LA	18	22
12	On	0.18	1	LA	16	38
13	Off	0.78	1	LA	40	46

Abbreviations: |dev| PP, magnitude of deciation in the primary position; Buckle rem., removal of buckle; GA, general anaesthetic; LA, local anaesthetic; Max|dev|, maximum deviation recorded in any position; N/R, record not available; PD, prism diopters; RD, retinal detachment.
[a]Anaesthetic used at the patients' final VR procedure.

Combined dev_h and dev_v were found in nine patients, whereas the remaining four had either dev_h or dev_v in the affected gaze position. The final VR surgery undertaken was performed under LA in six cases, under GA in three, and this information was not evident in four cases. Nine of the 13 patients (69%) had previous 'macula-on' RD. The median VA in this group was 0.18. The median |dev| in the PP was 8 PD, and in the area of maximum deviation, 22 PD. The PPV group had both the significantly higher numbers of previous VR procedures than the buckling group ($t = 2.56$, $P = 0.017$), and the significantly poorer VA ($U = 41.5$, $P = 0.046$). Three patients in the SB group did not require any further intervention or prism to overcome their diplopic symptoms. Four patients were treated with prisms, and one patient was treated with occlusion therapy due to intractable diplopia despite prism correction. Five patients underwent scleral buckle removal to improve ocular alignment; however, this did not result in a significant improvement.

The |dev| in the PP showed no significant difference between the PPV and SB groups ($U = 63$, $P = 0.41$); however, comparison of |dev| in the region of maximal deviation showed buckle patients to have significantly greater deviations ($U = 36.0$, $P = 0.02$).

Discussion

We retrospectively report 25 patients with diplopia following RD surgery, and demonstrate that both PPV and buckling procedures can have detrimental effects on ocular motility, despite the majority of the published literature being concerned with the latter. A total of 48% of our study group comprised of patients who, in contrast to other studies, had undergone PPV detachment repair. Wright *et al*[11] reported ocular motility problems in a group of PPV patients, where 4 of 17 patients had manifest deviations. In contrast, Fison and Chignell[10] did not find any patients with diplopia after vitrectomy in their series of 125 consecutive cases of vitrectomy patients.

It has previously been reported that the patients who are more likely to develop ocular motility problems following VR surgery are those with poorer vision,[7] and those with more surgical interventions.[6,8,9] Regression analysis of our patients has not, however, shown an association between these variables and magnitude of strabismus.

Mets *et al*[13] postulated that ocular motility defects after RD surgery resolve in many cases due to phoria adaptation. Heterotropias were demonstrated to resolve over 6 months, as patients become heterophoric or orthophoric through restoration of fusional reserves, which occurred in 80% of their cohort. Inclusion criteria for patients in our study were binocular diplopia documented at 2 months or longer, following RD surgery. This time point was chosen to identify patients likely to suffer with permanent diplopia given previous observations of phoria adaptation.[13] Furthermore, all patients in our study had persistent diplopia at a mean of 6 months following VR surgery, allowing for these natural changes to occur. It is plausible that within our cohort of patients, there are those with weak pre-operative fusional reserves, and who did not have the capacity to adapt. This theory is strengthened by several

patients in our cohort with binocular diplopia, despite very small angles of deviation.

Several mechanical causes for post-operative strabismus following RD repair have been postulated, including globe distortion by the mass effect of explants, damage to extraocular muscles by traction sutures, erosion of SB materials, scarring of tenon's capsule from orbital fat, and periocular anaesthesia.[7,14–18] Restrictive fibrosis has been observed during strabismus surgery following retinal cryopexy alone.[4,19,20] The differences seen in |dev| in the region of maximal deviation between our cohorts infers that of the several different mechanisms that may have a part in strabismus development; the presence of a buckle increases the deviation size in the extremes of gaze. This may be due to the tethering effect of buckling material on the vector forces of the muscles with which they are in direct contact, an effect that would be magnified in the more extremes of gaze.

Strabismus following diverse surgical procedures involving periocular anaesthesia is well-reported, and the use of intramuscular LA is a potential treatment for strabismus.[21] Salama *et al*[17] concluded trends in ocular deviation after RD surgery mirrored that encountered in reports of strabismus after cataract surgery, and postulated that restrictive strabismus was secondary to myotoxicity from periocular anaesthesia. Several mechanisms of induced-ocular motility defects have been postulated, which include direct injury from the needle, myotoxicity from intra-muscular injection, and ischaemia induced by raised-tissue pressure.[18–20,22,23] The majority of our cases were performed under LA (17 of 21 cases, where the data was available); however, this data must be treated with caution as seven cases had multiple operations in the course of managing their RD.

We report the largest cohort of post-PPV strabismus to date, and show that despite previous reports to the contrary, RD repair using PPV techniques still has a risk of strabismus development. The key differences between the PPV and SB groups in our study are: greater magnitude of deviation in maxDev amongst SB patients and the PPV cohort having significantly poorer VA, and undergoing multiple VR procedures. These differences imply that mechanisms leading to heterotropia between the two surgical groups may differ.

Wright *et al*[11] report similar rates of heterotropia between PPV and SB procedures in their prospective study. A minority of patients with external buckles in this study had diplopia (13%), compared with none in their vitrectomy group. Our study is therefore the first to highlight that patients can have symptomatic heterotropias after PPV for RD. We recognise in our unit that PPV is undertaken more frequently than SB procedures, and our sampling methods identified only diplopic patients who were referred for orthoptic assessment. It cannot therefore reflect the true incidence rates of strabismus following RD surgery. The limitations of our study reflect its retrospective design. Although all operation notes stated the position of the explant, few cases detailed perioperatively its size, type or orientation. Furthermore, we cannot comment on the relationship between fusional reserves, and frequency of ocular motility dysfunction without orthoptic assessment before RD.

Strabismus following VR surgery as a whole continues to be an issue, despite the advent of modern, less invasive procedures. These cases can be challenging to manage for the strabismus team. Further prospective enquiry to ascertain the mechanism of ocular motility disturbance after RD surgery is required in order to counsel the patients accordingly, and also to highlight those patients with a higher potential for developing strabismus post-operatively.

Summary

What was known before

- Acquired ocular motility defects occur after SB procedures. Heterotropias in most patients are transient and recovery may be through the process of phoria adaptation.

What this study adds

- This study demonstrates that patients can develop persistent and symptomatic ocular motility defects after vitrectomy. Overall magnitude of ocular deviation is greater among patients with SB in the gaze position of maximum deviation.

Conflict of interest

The authors declare no conflict of interest.

References

1 Waddell E. Retinal detachment and orthoptics. *Br Orthop J* 1983; **40**: 5–12.
2 Kanski JJ, Elkington AR, Davies MS. Diplopia after retinal detachment surgery. *Am J Ophthalmol* 1973; **76**: 38–40.
3 Metz MB, Wendell ME, Gieser RG. Ocular deviation after retinal detachment surgery. *Am J Ophthalmol* 1985; **99**: 667–672.
4 Portney GL, Campbell LH, Casebeer JC. Acquired heterotropia following surgery for retinal detachment. *Am J Ophthalmol* 1972; **73**: 985–990.
5 Price RL, Pederzolli A. Strabismus following retinal detachment surgery. *Am Orthop J* 1982; **32**: 9–17.
6 Sewell JJ, Knobloch WH, Eifrig DE. Extraocular muscle imbalance after surgical treatment for retinal detachment. *Am J Ophthalmol* 1974; **78**: 321–323.
7 Smiddy WE, Loupe D, Michels RG, Enger C, Glaser BM, deBustros S. Extraocular Muscle Imbalance after

Scleral Buckling Surgery. *Ophthalmology* 1989; **96**: 1485–1489.
8 Spencer AF, Newton C, Vernon SA. Incidence of ocular motility problems following scleral buckling surgery. *Eye* 1993; **7**: 751–756.
9 Maurino V, Kwan A, Khoo B, Gair E, Lee JP. Ocular motility disturbances after retinal detachment surgery. *J Am Assoc Pediatr Ophthalmol* 1998; **2**: 285–292.
10 Fison P, Chignell AH. Diplopia after retinal detachment surgery. *Br J Ophthalmol* 1987; **71**: 521–525.
11 Wright LA, Cleary M, Barrie T, Hammer HM. Motility and binocularity outcomes in vitrectomy versus scleral buckling in retinal detachment surgery. *Graefes Arch Clin Exp Ophthalmol* 1999; **237**: 1028–1032.
12 Coats DK, Olitski SE. *Strabismus Surgery and its Complications*. Springer-Varlag Berlin Heidelberg: New York, 2007, pp 168–169.
13 Mets MB, Wendell ME, Gieser RG. Ocular deviation after retinal detachment surgery. *Am J Ophthalmol* 1985; **99**: 667–672.
14 Kutschera E, Antlanger H. Influence of retinal detachment surgery on eye motility and binocularity. *Mod Probl Ophthalmol* 1979; **20**: 354–358.
15 Farr AK, Guyton DL. Strabismus after retinal detachment surgery. *Curr Opin Ophthalmol* 2000; **11**: 207–210.
16 Wright KW. The fat adherence syndrome and strabismus after retinal detachment surgery. *Ophthalmology* 1986; **93**: 415.
17 Salama H, Farr AK, Guyton DL. Anaesthetic myotoxicity as a cause of restrictive strabismus after scleral buckling surgery. *Retina* 2000; **20**: 578–582.
18 Gomez-Arnau JI, Wanguela J, Gonzalez A, Andrés Y, García del Valle S, Gili P *et al*. Anaesthesia-related diplopia after cataract surgery. *Br J Anaesth* 2003; **90**: 189–192.
19 Arruga A. Motility disturbances induced by operations for retinal detachment. *Mod Probl Ophthalmol* 1977; **18**: 408–414.
20 Munoz M, Rosenbaum AL. Long term strabismus complications following retinal detachment surgery. *J Pediatr Ophthalmol Strabismus* 1987; **24**: 309–314. after cataract surgery. Brit J Anaesth 2003; 90: 189–92.
21 Scott AB, Miller JM, Shich KR. Bupivacaine injection of the lateral rectus muscle to treat esotropia. *JAAPOS* 2009; **13**: 119–122.
22 Taylor G, Devys JM, Heran F, Plaud B. Early exploration of diplopia with magnetic resonance imaging after peribulbar anaesthesia. *Br J Anaesth* 2004; **92**(6): 899–901.
23 Hoyt C. A problem! Now a solution. Diplopia after cataract surgery. *Br J Ophthalmol* 2007; **91**: 127–128.