Published in final edited form as:
*J AAPOS*. 2013 December ; 17(6): . doi:10.1016/j.jaapos.2013.08.009.

# Risk factors influencing the outcome of strabismus surgery following retinal detachment surgery with scleral buckle

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## Abstract

**Purpose—**To determine factors associated with surgical success in patients undergoing strabismus surgery after retinal detachment repair with scleral buckle.

**Methods—**The medical records of consecutive patients who underwent strabismus surgery after repair of retinal detachment with scleral buckle were retrospectively reviewed. A successful "motor" outcome was defined as horizontal deviation $<10^{\Delta}$ and vertical deviation $<4^{\Delta}$ in the primary position; successful "sensory" outcome was no diplopia in the primary position. Various factors such as removing the scleral buckle at the time of strabismus surgery, the macula structural status, size of the preoperative deviation, presence of restriction to passive movement, and whether the eye with the scleral buckle was the operated eye were compared among groups based on motor success.

**Results—**A total of 25 patients were included. The overall motor success rate was 72% after 1.8 ± 0.9 operations, with 62% of patients diplopia free in the primary position. Horizontal deviation $<10^{\Delta}$ ($P = 0.005$) and minimal restriction on forced duction test were associated with motor success after the first surgery ($P = 0.05$). Partial or entire scleral buckle removal (n = 15) and fellow-eye surgery were not significantly correlated with motor success in our cohort. There were no retinal redetachments after scleral buckle removal.

**Conclusions—**A small preoperative horizontal deviation, and minimally restricted ocular rotations were associated with better results. Removing the scleral buckle did not improve results.

Transient strabismus after retinal detachment surgery is seen in up to 50% of patients and usually resolves in 3-6 months.[1-6] Persistent strabismus and diplopia occur in approximately 3.8% to 25%[1-3,7] of patients. The cause of strabismus after retinal detachment surgery is often multifactorial. Loss of fusion after retinal detachment due to decompensated heterophorias, poor vision or distortion due to macular damage, aniseikonia secondary to aphakia, or anisometropia from myopia induced by scleral buckle may lead to strabismus. [8-9] Additionally, the extraocular muscles may be directly damaged during retinal surgery by placement of the scleral buckle,[10] myotoxicity from retrobulbar anesthetic injection,[11] or cryotheraphy,[12-13] direct muscle injury[14] or malpositioning of a detached muscle.[14] Permanent adhesions and scarring from scleral dissection beneath a muscle insertion[15] or from orbital fat adherence[16] have also been implicated in postoperative strabismus. These adhesions can manifest as complicated incomitant strabismic deviations



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with horizontal or vertical or torsional components[5, 17] and even as rare strabismus types such as Brown syndrome[8] or anti-elevation syndrome.[17]

The reported success of strabismus surgery in patients after retinal detachment surgery with scleral buckle ranged from 47% to 80%.[9,18-19] Several studies[7,19-21] have tried to determine which factors are associated with poor prognosis and which might be responsible for more favorable outcomes. The purpose of this study was to investigate the factors that contribute to a successful motor outcome in the primary position after one or multiple strabismus operations in a cohort of patients with strabismus after scleral buckle procedure.

## Patients and Methods

This study was approved by the University of California–Los Angeles Institutional Review Board and conformed to the requirements of the US Health Insurance Portability and Accountability Act of 1996 and all relevant privacy laws. The medical records of all patients who underwent strabismus surgery at the Jules Stein Eye Institute from 1997-2012 for strabismus persistent for more than 6 months after retinal detachment repair with a scleral buckle with or without vitrectomy procedure were retrospectively reviewed. The minimum follow-up required was 4 weeks. Patients in whom muscle misalignment and the retinal detachment surgery were unrelated were excluded.

Data recorded included age at onset, diplopia symptoms, time to strabismus/diplopia, time to presentation, time to strabismus surgery, information about the scleral buckle procedure (including whether or not a vitrectomy or cryotherapy was performed), and the type of anesthesia. Ophthalmic information collected included best-corrected visual acuity, preoperative motor alignment at distance and near (using the alternate cover test or the modified Krimsky test[23]) and the structural status of the macula. Manifest horizontal ($dev_h$) and vertical ($dev_v$) were treated also as vectors and their magnitudes were combined | dev | as per mathematical convention to allow analysis:

$$|\mathrm{dev}|=\sqrt{\left(\mathrm{dev_h}^2+\mathrm{dev_v}^2\right)}.$$

Forced duction testing was performed immediately before and after strabismus surgery. A four-point grading scale, from –4.0 to 0, was used to assign a value to the forced duction test,[22] with 0 indicating full eye movement , –2 indicating a 50% reduction in movement, and –4 indicating no movement. Surgical techniques were determined by the surgeon's preference and have been published elsewhere.[22] Excision of scar tissue was performed in every case in which the surgery was performed in the involved eye. Adjustable sutures were used when possible.

Removal of the scleral buckle (either complete or partial scleral buckle removal, that is, excision and removal of a section of the scleral buckle beneath the operated extraocular muscle pathway), number of muscles operated on and opposite eye operation was also noted. In most cases, when adjustable sutures were needed or the scleral buckle was interfering with the recession of the muscle or with the access to the extraocular muscle itself, partial scleral buckle was performed. In 2 cases the sutures were passed beneath the scleral buckle, which was left intact. The decision to reoperate was determined by the surgeon and patient preferences, indicated by persistent diplopia and/or residual strabismus.

Subjects were divided into two groups based on whether or not surgery was ultimately successful, defined as motor horizontal deviation $<10^{\Delta}$ and vertical deviation $<4^{\Delta}$ at last measurement. The demographic features of the groups were compared using a 2-tailed *t* test

for continuous variables and a Fisher exact test for categorical variables. A *P* value of <0.05 was considered statistically significant and a Bonferroni correction was performed to adjust for multiple comparisons. Results are reported as mean and standard deviation.

## Results

A total of 25 patients (17 males [68%]) who underwent strabismus surgery after repair of retinal detachment in the period 1992-2012 were included. The mean age at the first strabismus evaluation was 53 ± 19 years (range, 11-73 years). Of the 25 patients, 4 had a history of prior strabismus surgery after retinal detachment repair performed by other surgeons: 2 patients had undergone a single prior surgery and the other 2 patients had undergone 2 prior surgeries. In 85% of surgeries adjustable sutures were used.

The average time between retinal detachment repair and onset of diplopia was 4 ± 10 months (range, 0-42), whereas the average time for the strabismus repair was 52 ± 97 months (range, 3-480 months). In addition to the scleral buckle procedure, 68% of patients also underwent pars plana vitrectomy, and 48% had cryotherapy. The macula was detached in 32% of cases, attached in 16%, and of unknown status in 52%. For the retinal detachment repair, 32% of patients had general anesthesia and 36% had local anesthesia; in 32% anesthesia type was unknown.

The pattern of strabismus was a combined horizontal and vertical deviation in 19 patients (8 with esotropia and 11 with exotropia), an isolated horizontal deviation in 4 (2 with esotropia and 2 with exotropia), and an isolated vertical deviation in 2 patients. The mean horizontal deviation was $18^{\Delta} \pm 12^{\Delta}$ at distance and $20^{\Delta} \pm 18^{\Delta}$ at near. The mean esotropia deviation was $13^{\Delta} \pm 8^{\Delta}$ for distance and $11^{\Delta} \pm 12^{\Delta}$ for near, and the mean exotropia deviation was $25^{\Delta} \pm 10^{\Delta}$ for distance and $30^{\Delta} \pm 17^{\Delta}$ for near. The mean vertical deviation was $7^{\Delta} \pm 7^{\Delta}$ at distance and $6.5 \pm 7^{\Delta}$ at near. Four patients had sensory exotropia without preoperative diplopia and strabismus surgery was performed for psychosocial reasons.

Thirteen patients (52%) had subsequent strabismus surgical procedures after the initial surgery (from 1 to 3 additional procedures). Surgery for consecutive exotropia was performed on 6 of 13 patients. The remaining 7 patients had surgery for residual hypertropia (2), consecutive esotropia (1), residual excyclotorsion (1), consecutive hypotropia (1) and consecutive hypertropia (2).

Six patients underwent multiple reoperations, with 5 patients undergoing 2 reoperations, and 1 patient undergoing 3 reoperations. Seven patients deferred further surgery although their motor alignment was unsuccessful. Of these 7 patients, 2 had sensory exotropia with residual exotropia, 1 had a residual exotropia and no diplopia, 2 had residual exotropia of the convergence insufficiency type, 1 had a consecutive hypotropia, and 1 had a residual esotropia and hypertropia. The mean follow-up after the final operation was 12 ± 17 months (range, 1-60 months). No patient suffered retinal redetachment after removal of the scleral buckle.

### Success Rates

Overall, 9 of 25 patients (36%) had a successful outcome after one surgery with 18 patients (72%) ultimately achieving a successful motor outcome after multiple surgeries. Thirteen patients (52%) underwent multiple strabismus operations and 9 patients (70%) had a successful motor outcome.

Of the 21 patients with fusion potential preoperatively, 13 (62%) had a successful sensory outcome and 8 (38%) had persistent diplopia. Four of these were considered to have motor

success. The reasons for the diplopia in these 4 patients were horizontal diplopia in lateral gaze in 1 patient and diplopia due to residual hypertropia between $2^{\Delta}$ and $4^{\Delta}$ in the remaining 3 patients. Of the 9 patients having just one surgery, 8 had preoperative fusion potential with 6 (75%) having a successful sensory outcome. In the remaining 2 patients with residual diplopia, one had excyclotorsion of 10° (measured by double Maddox rod) and 1 had hypertropia of $2^{\Delta}$ combined with $2^{\Delta}$ of exotropia that he could not fuse.

### Risk Factor Analysis for "Successful" Outcomes

Univariate analysis (Table 1) revealed that smaller horizontal deviation ($P = 0.005$), smaller total deviation vector ($P = 0.01$), and forced duction testing ≤2 ($P = 0.05$) were statistically significant associations with excellent motor outcome after the first operation. No correlation was found between motor success and operation on the fellow eye ($P = 0.5$) or removal of scleral buckle ($P = 0.6$) in our subjects.

Univariate analysis (Table 2) revealed that smaller horizontal deviation ($P = 0.006$) and smaller total deviation vector ($P = 0.01$) were associated with successful motor outcome overall after multiple operations. No association was found between motor success and operation on the fellow eye ($P = 0.1$) or scleral buckle removal ($P = 0.99$).

## Discussion

The present study found an overall motor success rate of 72% for patients undergoing surgery for strabismus after retinal detachment repair using sclera buckle. About one third of patients (38%) had some residual diplopia at the final follow-up examination. Approximately half of our patients required more than one surgery. These data reflect the complicated nature of the strabismus after scleral buckle surgery and agree with previously published success rates, which range between 47% and 80%.[9,18-19]

In our subjects, we also found that smaller horizontal deviations and smaller total deviation vectors were associated with better motor outcomes. Additionally, less restriction on forced duction testing was significantly associated with motor alignment success after one strabismus operation. These findings, while not surprising, have not been demonstrated previously in this population and may be useful in counseling patients undergoing strabismus surgery after retinal detachment repair.

The presence of an exoplant often makes strabismus surgery more difficult due to adhesions and anatomical distortions. Removing scleral buckling material during strabismus surgery has been suggested,[19] but there is no current consensus on this point. Deokule and colleagues[21] detailed 2 of 72 patients in whom diplopia was the only indication for scleral exoplant removal. The diplopia persisted in these 2 patients and subsequent strabismus treatment was required. Similarly, Wong and colleagues[20] reported that in 5 patients sole removal of the scleral exoplant did not affect the magnitude of strabismus in the primary position or alleviate the patients' symptoms. Munoz and Rosenbaum[18] reported that in 42% of their patients with hypotropia, the exoplant was actually placed in other locations than inferiorly. Recently, Goezinne and colleagues[7] also found no correlation between the position of the buckle and the restriction of the muscle under which the buckle was placed; moreover, in the majority of cases in the diplopia group, the buckle was not underneath the muscle that would be expected to be associated with the diplopia. Consequently, many authors[18-20] have suggested that removal of the scleral buckle as a standardized procedure would not necessarily change the strabismus outcome and should therefore only be considered if the exoplant seems to be causally related to the deviation. Conversely, Fison and Chingell[19] reported 6 cases that underwent exoplant removal as a sole procedure. Of the 6 patients, 1 patient had complete resolution of symptoms; however, 3 patients experienced

improvement in their size of deviation (mainly in vertical misalignment), which then allowed single vision to be maintained by either introduction of prisms or using a compensatory head posture or suppression.

In the present study, we could not demonstrate any benefit of scleral buckle removal on the motor alignment outcome after one or multiple surgeries ($P = 0.6$ and $P = 0.99$, respectively). One possible explanation for this finding is that our study was underpowered for detecting a difference between groups or exoplant removal is not an essential part of surgery in these cases. Although, we have not had any incidence of redetachment of the retina following scleral buckle removal, this complication has been reported in 4% to 33% of cases.[21,24]

This study found that more restriction on forced duction testing was associated with less successful outcomes. It may be helpful to make the distinction between restrictive and nonrestrictive causes of strabismus in this group of patients. First, this may be an important prognostic factor, as demonstrated by our data. Additionally, if the etiology of strabismus is felt to be nonrestrictive, surgical correction of the horizontal deviation can be considered on the fellow eye with greater ease and less risk of retinal redetachment. When mechanical restrictions is associated with severe rotational limitation, a surgical approach to the affected eye is likely necessary.[17]

This study has several important limitations. As a retrospective study, some patient data was unavailable, including the exact location of the exoplant as well as its size, type, or orientation. Three different surgeons performed the surgeries, each with different surgical techniques and preferences. The range of ages and follow-up is wide and thus demonstrates variability within our patient population. Finally, our patient cohort was not uniform, with some subjects undergoing multiple surgeries while others declined more surgery.

## Acknowledgments

Grant support: NIH/NEI K23EY021762 (SLP), Knights Templar Eye Foundation (SLP), Oppenheimer Family Foundation (SLP).

## References

1. Price RL, Pederzolli A. Strabismus following retinal detachment surgery. Am Orthop J. 1982; 32:9–17.
2. Amemiya T, Yodhida H, Harayama K, Miki M, Koizumi K. Long-term results of retinal detachment surgery. Ophthalmologica. 1978; 177:64–9. [PubMed: 745823]
3. Roth AM, Sypnicki BA. Motility dysfunction following surgery for retinal detachment. Am Orthop J. 1975; 25:118–21.
4. Theodossaidis G, Nikolakis S, Apostolopoulos M. Immediate postoperative muscular disturbance in retinal detachment surgery. Mod Probl Ophthalmol. 1979; 20:367–72. [PubMed: 548773]
5. Metz HS, Norris A. Cyclotorsional diplopia following retinal detachment surgery. J Pediatr Ophthalmol Strabismus. 1987; 24:287–90. [PubMed: 3694384]
6. Metz MB, Wendell ME, Gieser RG. Ocular deviation after retinal detachment surgery. Am J Ophthalmol. 1985; 99:667–72. [PubMed: 4014390]
7. Goezinne F, Berendschot TT, Van Daal EW, et al. Diplopia was not predictable and not associated with buckle position after scleral buckling surgery for retinal detachment. Retina. 2012; 32:1514–24. [PubMed: 22466475]
8. Farr AK, Guyton DL. Strabismus after retinal detachment surgery. Curr Opin Ophthalmol. 2000; 11:207–10. [PubMed: 10977229]
9. Maurino V, Kwan A, Khoo B, Gair E, Lee JP. Ocular motility disturbances after surgery for retinal detachment. J Am Assoc Pediatr Ophthalmol. 1998; 2:285–92.

10. Wright KW, Hwang JM. Diplopia and strabismus after retinal and glaucoma surgery. Am Orthop J. 1994; 44:26–30.
11. Salama H, Farr AK, Guyton DL. Anesthetic myotoxicity as a cause of restrictive strabismus after scleral buckling surgery. Retina. 2000; 20:578–82.
12. Bell FC, Pruett RC. Effects of cryotheraphy upon extraocular muscle. Ophthalmic surg. 1977; 8:71–5. [PubMed: 865770]
13. Hamlet YJ, Goldstein JH, Rosenbaum JD. Dehiscence of lateral rectus muscle following intrascleral buckling procedure. Ophthalmology. 1989; 96:1485–9. [PubMed: 2587043]
14. Arruga A. Binocularity after retinal detachment surgery. Doc Ophthalmol. 1973; 34:41–5. [PubMed: 4706108]
15. Wolff SM. Strabismus after retinal detachment surgery. Trans Am Ophthalmol Soc. 1983; 81:182–92. [PubMed: 6676969]
16. Wright KW. The fat adherence syndrome and strabismus after retinal surgery. Ophthalmology. 1986; 93:411–15. [PubMed: 3703512]
17. Cooper LL, Harrison Rosenbaum AL. Ocular torsion as a complication of scleral buckle procedure for retinal detachment. J Am Assoc Pediatr Ophthalmol. 1998; 2:279–84.
18. Munoz M, Rosenbaum AL. Long-term strabismus complications following retinal detachment surgery. J pediatr ophthalmol strabismus. 1987; 24:309–14. [PubMed: 3320328]
19. Fison P, Chignell AH. Diplopia after retinal detachment surgery. Br J Ophthalmol. 1987; 71:521–5. [PubMed: 3651365]
20. Wong V, Kasbekar S, Young J, Stappler T, Marsh IB, Durnian JM. The effect of scleral exoplant removal on strabismus following retinal detachment repair. J AAPOS. 2011; 15:331–3. [PubMed: 21907112]
21. Deokule S, Reginald A, Callear A. Scleral exoplant removal: the last decade. Eye. 2003; 17:697–700. [PubMed: 12928679]
22. Rosenbaum, AL.; Santiago, AP., editors. Clinical Strabismus Management: Principles and Surgical Techniques. Saunders; Philadelphia: 1999. p. 11
23. Schwartz, GS. The eye exam: a complete guide. Slack; New Jersey: 2006. p. 102-103.
24. Schwartz PL, Pruett RC. Factors influencing retinal redetachment after removal of buckling elements. Arch Ophthalmol. 1977; 95:804–7. [PubMed: 871264]

## Table 1

Success at first surgery outcome

| Preoperative parameter | No Success (n = 16) | Success (n = 9) | *P* value[a] |
|---|---|---|---|
| Age, years | 49 ± 19 | 60 ± 16 | 0.2 |
| Macula status | 8/12 macula on, 8/13 macula off | 4/12 macula on, 5/13 macula off | 0.8 |
| Time to strabismus surgery, months | 70 ± 122 | 24 ± 17 | 0.27 |
| VA in RD eye | 0.4 ± 0.3 | 0.4 ± 0.3 | 0.8 |
| Horizontal deviation, PD | 22 ± 11 | 9 ± 9 | 0.005[b] |
| Vertical deviation, PD | 7 ± 5 | 8 ± 9 | 0.6 |
| Excyclotorsion | 3.9 ± 6.5 | 34 ± 2.4 | 0.8 |
| Surgery on RD eye vs fellow vs bilateral | 13/17 RD eye, 1/3 fellow eye, 3/5 bilateral | 5/17 RD eye, 2/3 fellow, 2/5 bilateral | 0.5 |
| SB removed | 6/10 no removal, 10/14 with segmental or entire explant | 4/10 no removal, 4/14 with segmental or entire explant | 0.6 |
| FDT | 11/19 with FDT<2, 4/4 with FDT >2 | 8 of 19 with FDT <2, 0 of 4 with FDT >2 | 0.05 |
| Total deviation (vector) | 25 ± 9 | 16 ± 7 | 0.01 |

*FDT*, forced duction testing; *PD*, prism diopter; *RD*, retinal detachment; *SB*, scleral buckle; *VA*, visual acuity.

[a] Based on *t* test for continuous variables and the Fisher exact test for categorical variables; $P < 0.05$ was considered significant.

[b] Using Bonneferoni correction, $P < 0.005$ was considered significant.

## Table 2

Success at final visit outcome

| Preoperative parameter | No Success (n = 7) | Success (n = 18) | *P* value[a] |
|---|---|---|---|
| Age | 47 ± 15 | 56 ± 19 | 0.3 |
| Macula status | 5/13 macula off, 2/12 macula on | 8/13 macula off, 10/12 macula on | 0.2 |
| Time to strabismus surgery, months | 115 ± 183 | 30 ± 23 | 0.06 |
| VA in RD eye | 0.2 ± 0.3 | 0.4 ± 0.3 | 0.2 |
| Horizontal deviation, PD | 30 ± 12 | 13 ± 9 | 0.006 |
| Vertical deviation, PD | 6.4 ± 5 | 7.6 ± 7.8 | 0.7 |
| Excyclotorsion | 4.5 ± 8 | 3.3 ± 3.6 | 0.7 |
| Surgery on RD eye vs fellow vs bilateral | 1/4 RD, 0/6 fellow | 3/4 RD, 6/6 fellow | 0.1 |
| SB removed | 0/9 no, 2/3 yes | 9/9 no, 1/3 yes | 0.99 |
| Diplopia | 5/21 preoperative diplopia, 2/4 no diplopia | 16/21 preoperative diplopia, 2/4 no diplopia | 0.5 |
| Total deviation (vector) | 31 ± 10 | 17 ± 6 | 0.01 |

*PD*, prism diopter; *RD*, retinal detachment; *SB*, scleral buckle; *VA*, visual acuity.

[a]Based on *t* test for continuous variables and the Fisher exact test for categorical variables; $P < 0.05$ was considered significant.