Incidence and Risk Factors for Intraocular Pressure Rise after the Scleral Buckle Surgery for Retinal Detachment

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Abstract

Purpose: To determine the incidence and risk factors for intraocular pressure (IOP) rise after the scleral buckle (SB) procedure for retinal detachment (RD).

Methods: A retrospective chart review of the medical records of patients, who underwent RD repair by SB performed by a single surgeon and had a minimum follow-up of 6 months was carried out. The outcome measures were the incidence of IOP rise in the operated eyes and the associated risk factors.

Results: Fifty-two eyes of 52 patients with a median postsurgical follow-up of 18 months (interquartile range: 6, 36, range: 6–60 months) were included. Seven eyes had encircling buckle, 23 eyes had encircling buckle and 1 quadrant segmental buckle, and 22 eyes had encircling buckle and 2 quadrant segmental buckle. IOP rise was seen in 15/52 eyes (28.85%), within 1 month of the SB surgery. Nine out of 15 eyes (60%) of patients <40 years of age had a rise in IOP as compared to 6/37 eyes (16.2%) of patients >40 years of age (P = 0.002). Patients <40 years had a significant increased risk of developing IOP rise, compared to those above 40 years of age (adjusted odds ratio: 7.246 with 95% confidence interval of 1.641–31.986, P = 0.009). None of the fellow eyes had a rise in IOP during the follow-up period. None of the operated eyes with raised IOP progressed to glaucoma.

Conclusions: Elevated IOP is a common complication after the SB procedure, and age <40 years is associated with a greater risk of development of increase in the IOP. Hence, IOP monitoring after the SB surgery is of paramount importance to detect early rise during follow-up.

Keywords: Glaucoma, Intraocular Pressure, Retinal Detachment, Scleral Buckle

INTRODUCTION

Etiology of intraocular pressure (IOP) rise and glaucoma after an encircling scleral buckle (SB) surgery for retinal detachment (RD) is multifactorial.1-3 Mechanisms which are proposed for the early rise in IOP are steroid-induced elevation of IOP, exacerbation of preexisting ocular hypertension (OHT) or glaucoma, congestion, and anterior rotation of the ciliary body, which results in secondary angle closure.

There have been case reports of visual field loss in patients with SB, which was associated with a reduction in choroidal blood flow.2,3 Majority of the previous studies have reported on changes in the choroidal blood flow and retinal circulation after SB.1-3 Knowledge about the incidence in IOP rise at different time intervals and its risk factors after the SB procedure can help us suspect, identify, and manage IOP rise in the postoperative follow-up period. Hence, this study was undertaken.

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The aim of the study was to analyze the incidence and risk factors for IOP rise after the SB surgery for RD in the eyes without a previous history of glaucoma or OHT.

**Methods**

In this retrospective, observational study, medical records of the patients who underwent RD repair surgery with the SB and had a minimum follow-up of 6 months were reviewed. All the surgeries were performed by a single surgeon (S.G.A.) from August 2013 to December 2018. Seven eyes had an encircling buckle, 23 eyes had an encircling buckle and 1 quadrant segmental buckle, and 22 eyes had an encircling buckle and 2 quadrant segmental buckle. Institute internal review board approval was obtained. Written informed consent was obtained from all the participants for the surgery as well as for the use of patients’ data for research work, as is the standard protocol in our institute for any procedure performed. The study was carried out in accordance with the tenets of the Declaration of Helsinki for research involving human subjects.

Under local anesthesia, 360° limbal peritomy of conjunctiva/Tenon with two relaxing incisions, 180° apart was done. All the four muscles were tagged. Posterior and lateral extent of the break/lattice was marked. Cryotherapy was done to the break or lattice, and a 240 encircling silicone band (MIRA, Inc., USA) was passed under the recti muscle and anchored with the anchoring sutures. In cases required, segmental buckle was placed in the corresponding quadrant/s of the break/lattice. Band tie was applied in the quadrant opposite to the SB. Subretinal fluid drainage was performed along the superior or inferior margins of the medial or lateral rectus. Buckle and belt buckle were tightened. Fundus examination was done at the end of the surgery to look for the position of buckle and central retinal artery pulsations. In the presence of central retinal artery pulsation, paracentesis was performed. Conjunctiva and Tenon’s were closed in the layers with 7–0 vicryl suture.

Postoperatively, patients were started on topical 1% prednisolone acetate, 6 times/day for a week, which was tapered weekly as five times daily for a week, 4 times daily for a week, thrice daily for a week, twice daily for a week, and once daily for a week. If any patient was noted to have a rise in the IOP ≥ 22 mmHg, they were switched over to topical 0.5% loteprednol etabonate, and antiglaucoma medication (AGM) was added in the medical regimen for the management of raised IOP.

History and clinical examination were recorded pre and postoperatively. IOP was measured by a calibrated Goldmann applanation tonometer, preoperatively and on day 1, 1 week, 1 month, 3 months, 6 months, and yearly during the follow-up visits following the surgery.

Patients who had a history of ocular trauma, vitrectomy with SB, vitrectomy with tamponading agents, bilateral SB, prior diagnosis of OHT, glaucoma, or patients on AGM in either of the eyes, one-eyed patients or patients with a history of intravitreal corticosteroid and patients with pneumatic retinopexy at the end of surgery were excluded.

Patients with IOP >21 mmHg were referred to the glaucoma clinic where the IOP was rechecked, gonioscopy and optic disc evaluation was performed, and the patients were started on the AGM, as needed. Glaucoma diagnosis was made based on IOP >21 mmHg, glaucomatous optic nerve damage (documented increase in the cup-to-disc ratio, neuroretinal rim thinning), and corresponding visual field defect on SITA standard, 24-2 Humphrey visual field.

Statistical analysis was performed using the SPSS software Version 17 (IBM Corp., Chicago, IL, USA). Descriptive statistics included mean deviation and standard deviation for normally distributed continuous variables and median and interquartile range (IQR) for nonnormally distributed variables. Kolmogorov–Smirnov test was used to test the distribution of continuous variables. IOP was compared between operated eye and fellow eyes at each time-point using the Mann–Whitney U-test. Chi-square test was used to obtain the associations between categorical variables. Risk estimates (odds ratio [OR]) were assessed by multiple logistic regression analysis. A P < 0.05 was considered statistically significant.

**Results**

Medical records of 55 consecutive patients who underwent unilateral SB and were followed up for 6 months were reviewed. Of these, two patients who had a history of trauma and 1 with OHT were excluded from the analysis. Fifty-two patients (40 male and 12 female) met the inclusion criteria. The median postsurgical follow-up duration was 18 months (IQR: 6, 36, range: 6–60 months). Demographic and clinical data of the study participants are shown in Table 1.

An IOP rise of >21 mmHg was seen in 15/52 eyes (28.85%), which occurred within 1 month after the SB procedure. In 2/52 eyes (3.85%), IOP rise occurred on 1 day postoperatively after SB and in 6/52 eyes (11.54%), IOP rise occurred 1 week after the SB procedure. At 1-month postsurgical period, 7/52 eyes (13.46%) showed an increase in the IOP. At 3-month postsurgical period, all the 15 eyes had controlled IOP, in which 4 eyes were on AGM. The maximum rise in IOP was seen between the 1st week and 1 month following the SB. None of the eyes with elevated IOP progressed to glaucoma. In all the eyes, IOP was controlled on discontinuing steroids and addition of AGM, and none required surgery for the control of IOP. In 2 eyes, IOP was controlled with a single AGM, 7 eyes were on fixed drug combination, 4 eyes were on 3 AGM, and 2 eyes were on 4 AGM, including oral acetazolamide. AGM was discontinued in 14 eyes during the follow-up period. At the last follow-up visit, only one patient was on a single AGM. In 93.3% (14/15) eyes, the IOP was within normal limits by 6 months without AGM, and 6.7% (1/15) eyes needed to continue AGM beyond 6 months. All the eyes with raised IOP had open angles on gonioscopy, which was performed at
a variable time period, mostly between 4 and 6 weeks after the surgery.

Ten out of 40 males (25%) had a rise in IOP as compared to 5/12 (41.7%) females (P = 0.26). Females did not have an increased risk of rise in IOP, when compared to males (OR: 1.324, with confidence interval [CI] 95% CI) [6.282–0.218, P = 0.72). Nine out of 15 eyes (60%) of patients <40 years had a rise in IOP when compared to 6/37 eyes (16.2%) of patients >40 years of age (P = 0.002). The mean age of patients with normal IOP was 46.14 ± 14.41 years when compared to the mean age (33.8 ± 21.46 years, P = 0.02) of patients with raised IOP. Patients <40 years of age had a significantly increased risk of developing IOP rise when compared to those above 40 years of age (OR: 7.246, 95% CI: 1.641–31.986, P = 0.009).

The mean baseline IOP of patients without an increase in the postoperative IOP was 12.05 ± 3.28 mmHg when compared to the mean IOP (11.93 ± 3.55 mmHg, P = 0.53) of the patients with raised IOP.

Baseline IOP did not have a significantly increased risk of developing IOP rise (OR: 1.003, 95% CI: 0.806–1.249, P = 0.98).

Mean spherical equivalent of the patients with normal IOP was −3.03 ± 3.95 diopters (D) when compared with the mean spherical equivalent of patients with raised IOP (−3.1 ± 3.03 D, P = 0.95). Patients with high myopia were not found to have increased risk of developing IOP rise when compared to those with myopia and less spherical power (OR: 0.995, 95% CI: 0.844–0.954, P = 0.95).

The fellow eyes had a significantly higher baseline mean IOP of 13.29 ± 1.93 mmHg when compared to the eye with RD (12.02 ± 3.33 mmHg, P = 0.02) [Table 2]. At 1 week postoperatively, operated eyes had a mean IOP of 17.43 ± 5.83 mmHg when compared with 14.29 ± 2.14 mmHg in the fellow eye (P = 0.01). At 1 month postoperatively, operated eyes had a mean IOP of 17.32 ± 9.87 mmHg when compared with 13.48 ± 2.95 mmHg in the fellow eye (P = 0.02) [Table 2]. Beyond 1 month, there was no statistically significant difference in the mean IOP between the operated and the fellow eye, with 9 eyes on AGM at 1 month, 4 eyes on AGM at 3 months, and 1 eye on AGM at and beyond 6 months in the operated eye.

**DISCUSSION**

Incidence of IOP elevation and/or angle-closure glaucoma after the SB has been reported to vary from 1.4% to 4.4%,6–9 The proposed mechanism is that the SB causes flattening of sclera over the ciliary body, causing anterior rotation of ciliary process which in turn causes anterior rotation of ciliary process with anterior displacement of the lens-iris diaphragm. This could lead to a direct angle narrowing and a rise in IOP. Reduction in choroidal blood flow has been reported to induce visual field changes in open-angle glaucoma patients, despite normal IOP.1–4 Using noninvasive laser Doppler technique, a study reported reduced retinal blood flow in five patients who underwent uncomplicated SB procedure. Using bidirectional laser Doppler, at an average of 4 years after the SB and an increase in the blood flow through the retinal arteries, after the removal of buckling elements. Another study showed a decline in the blood velocity in the choroid and retina, using a laser speckle method. Other studies have

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**Table 1: Baseline characteristics of the study group (n=52)**

| Age (years)* | Operated eye | Fellow eye |
|--------------|--------------|------------|
| 40.5 (28.3, 58.8) | 40/12 | |
| Gender (male/female) | | |
| Laterality of eye (right/left) | 25/27 | |
| Duration of presentation since the onset of symptoms (days)* | 7 (3.5, 17.5) | |
| Time of patients presentation to the surgery duration (days)* | 2 (1, 3) | |
| Follow-up duration (months)* | 18 (6, 36) | |
| Preoperative spherical equivalent (diopter)* | −3.5 (−5.6, −1.9) | −1.5 (−5.0, −0.5) |
| Postoperative spherical equivalent (diopter)* | −3.0 (−6.2, −1.8) | |
| Preoperative best corrected visual acuity (logMAR) at presentation* | 1.0 (0.6, 1.3) | 0.0 (0.0, 0.2) |
| Postoperative best corrected visual acuity (logMAR)* | 0.6 (0.2, 1.2) | |
| Number of antiglaucoma medications postsurgery* | 0 (0, 1.7) | |
| Lens status | | |
| Phakia | 33 | 40 |
| Pseudophakia | 18 | 12 |
| Aphakia | 1 | |

*Values are given as median (Interquartile range)

**Table 2: Difference in intraocular pressure at baseline and follow-up visits in the operated and the fellow eye**

| Intraocular pressure (mmHg) (number of patients at the follow-up visit) | Operated eye | Fellow eye | P* |
|------------------------------------------------------------------------|--------------|------------|----|
| Baseline                                                               | 12.02±3.33   | 13.29±1.93 | 0.02 |
| 1 week (n=52)                                                          | 17.43±5.83   | 14.29±2.14 | 0.01 |
| 1 month (n=50)                                                         | 17.32±9.87   | 13.48±2.95 | 0.02 |
| 3 months (n=51)                                                        | 13.53±3.21   | 14.00±2.28 | 0.53 |
| 6 months (n=52)                                                        | 12.57±1.96   | 12.75±1.52 | 0.71 |
| 1 year (n=25)                                                          | 13.88±4.37   | 13.17±1.79 | 0.46 |
| 2 years (n=22)                                                         | 12.27±1.28   | 12.86±1.74 | 0.22 |
| 3 years (n=11)                                                         | 14.09±1.92   | 13.80±1.75 | 0.72 |
| 4 years (n=6)                                                          | 14.33±1.97   | 14.80±1.79 | 0.69 |
| 5 years (n=8)                                                          | 13.00±1.51   | 12.25±1.28 | 0.3 |
| Last follow-up (n=52)                                                  | 13.13±3.45   | 13.17±1.96 | 1.07 |

*Based on nonparametric test of Mann–Whitney U test
reported that the ocular circulation disturbances after the SB are transient, as measured by laser Doppler flowmetry, and it was found that both the retinal and choroidal blood flow in the macular region returned to fellow eye levels within 3 months after surgery.\textsuperscript{12,13}

Using enhanced depth imaging optical coherence tomography, choroidal thickness showed an increase immediately after the SB surgery, which returned to the normal levels within 4 weeks.\textsuperscript{14}

Choroidal effusion may be induced by compression of the vortex veins due to a broad scleral indentation, by excessive cryoretinopexy, or by drainage of subretinal fluid during surgery leading to a swelling and anterior rotation of the ciliary body, as well as forward shift in the lens–iris diaphragm, with a subsequent narrowing or closure of the angle.\textsuperscript{6,9,15-17} Preexisting narrow angle, use of a 360° buckle, high myopia, and older age have also been reported as risk factors for secondary angle closure.\textsuperscript{15-17}

Pinninti et al.\textsuperscript{3} in a study of 68 patients that underwent an encircling SB showed no evidence of increased risk for developing glaucoma after the RD repair compared with the fellow eyes, with a follow-up of at least 10 years. In this study, perimetric glaucoma was present in 2.9% of patients in the SB eyes, 8.8% in the fellow eye ($P = 0.27$), and 1.3% in both the eyes. In a series of 12 eyes with preexisting glaucoma that underwent encircling SB for RD, the IOP was found to be lower in the operated eye, and there was no evidence of progression of visual field loss over a follow-up period of 5.5 years.\textsuperscript{18}

Our study found that the incidence of IOP rise was 28.8% in the eyes that underwent the SB procedure, compared with the fellow eyes. This is in contrast to the previous study\textsuperscript{3} where the age of the study participants was not mentioned. In our study, none of the eyes with raised IOP progressed to glaucoma. Gender, myopia, and baseline IOP were not found to be the risk factors for a rise in IOP. Age <40 years was found to be a risk factor for the development of an increase in IOP. None of the eyes had secondary angle closure. Steroid-induced IOP rise was the most probable causative factor in all the patients. The AGM was withdrawn subsequently during the follow-up visits, and at 6-month postoperative period, only one eye needed single AGM for the IOP control.

A higher than average risk for steroid-induced glaucoma is found in patients with young age (<6 years old) or an older age\textsuperscript{19} and high myopia.\textsuperscript{20} Our study found that a younger age of <40 years is a risk factor for the IOP rise, which was attributed to the postoperative topical steroid use. Withdrawal of steroids and addition of AGM was effective in bringing the IOP to the baseline level in all these patients.

Limitations of the study include small sample size, retrospective nature, variable follow-up time period, and the study participants having myopia $<\sim 13$ D.

In conclusion, IOP monitoring after the SB surgery is of paramount importance. Young patients <40 years should be monitored closely, especially in the first 3 months postoperatively, and the topical steroids should be tapered based on the level of IOP, possibly early in these patients.

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\textbf{Conflicts of interest}

There are no conflicts of interest.

\textbf{REFERENCES}

1. Yoshida A, Feke GT, Green GJ, Goger DG, Matsuhashi M, Jalkh AE, et al. Retinal circulatory changes after scleral buckling procedures. Am J Ophthalmol 1983;95:182-8.
2. Sato EA, Shinoda K, Inoue M, Ohtake Y, Kimura I. Reduced choroidal blood flow can induce visual field defect in open angle glaucoma patients without intraocular pressure elevation following encircling scleral buckling. Retina 2008;28:493-7.
3. Kimura I, Shinoda K, Eshita T, Inoue M, Mashima Y. Relaxation of encircling buckle improved choroidal blood flow in a patient with visual field defect following encircling procedure. Jpn J Ophthalmol 2006;50:554-6.
4. Sasoh M, Ito Y, Wakitani Y, Matsubara H, Matsunaga K, Uji Y. 10-year follow-up of visual functions in patients who underwent scleral buckling. Retina 2005;25:965-71.
5. Pinninti UR, McPherson AR, Carvounis PE. Long-term risk of glaucoma after encircling scleral buckle. Retina 2015;35:1084-6.
6. Sebestyen JO, Schepens CL, Rosenthal ML. Retinal detachment and glaucoma. I. Tonometric and gonioscopic study of 160 cases. Arch Ophthalmol 1962;67:736-45.
7. Hartley RE, Marsh RJ. Anterior chamber depth changes after retinal detachment. Br J Ophthalmol 1973;57:546-50.
8. Kreiger AE, Hodgkinson BJ, Frederick AR Jr., Smith TR. The results of retinal detachment surgery. Analysis of 268 operations with a broad scleral buckle. Arch Ophthalmol 1971;86:835-94.
9. Perez RN, Phelps CD, Burton TC. Angel-closure glaucoma following scleral buckling operations. Trans Sect Ophthalmol Am Acad Ophthalmol Otolaryngol 1976;81:247-52.
10. Ogasawara H, Feke GT, Yoshiida A, Milbocker MT, Weiter JJ, McMeel JW. Retinal blood flow alterations associated with scleral buckling and encircling procedures. Br J Ophthalmol 1992;76:275-9.
11. Nagahara M, Tamaki Y, Araie M, Eguchi S. Effects of scleral buckling and encircling procedures on human optic nerve head and retinochoroidal circulation. Br J Ophthalmol 2000;84:31-6.
12. Eshita T, Shinoda K, Kimura I, Kitamura S, Ishida S, Inoue M, et al. Retinal blood flow in the macular area before and after scleral buckling procedures for rhegmatogenous retinal detachment without macular involvement. Jpn J Ophthalmol 2004;48:358-63.
13. Sugawara R, Nagaoka T, Kitaya N, Fujino N, Takahashi J, Takahashi A, et al. Choroidal blood flow in the foveal region in eyes with rhegmatogenous retinal detachment and scleral buckling procedures. Br J Ophthalmol 2006;90:1363-5.
14. Miura M, Arimoto G, Tsukahara R, Nemoto R, Iwasaki T, Goto H. Choroidal thickness after scleral buckling. Ophthalmology 2012;119:1497-8.
15. Hayreh SS, Baines JA. Occlusion of the vortex veins. An experimental study. Br J Ophthalmol 1973;57:217-38.
16. Diddie KR, Ernest JT. Uveal blood flow after 360 degrees constriction in the rabbit. Arch Ophthalmol 1980;98:729-30.
17. Kawana K, Okamoto F, Hiraoka T, Oshika T. Ciliary body edema after scleral buckling surgery for rhegmatogenous retinal detachment. Ophthalmology 2006;113:36-41.
18. Friedman Z, Neumann E. Effect of retinal detachment surgery on the course of preexisting open-angle glaucoma. Am J Ophthalmol
19. Lam DS, Fan DS, Ng JS, Yu CB, Wong CY, Cheung AY. Ocular hypertensive and anti-inflammatory responses to different dosages of topical dexamethasone in children: A randomized trial. Clin Exp Ophthalmol 2005;33:252-8.

20. Marcus MW, de Vries MM, Junoy Montolio FG, Jansonius NM. Myopia as a risk factor for open-angle glaucoma: A systematic review and meta-analysis. Ophthalmology 2011;118:1989-94.e2.