Original Article

Taiwan J Ophthalmol 2017;7:94-99

Access this article online

Quick Response Code:

Website:
www.e-tjo.org

DOI:
10.4103/tjo.tjo_7_17

# Scleral buckling-induced ocular parameter changes in different age group patients of rhegmatogenous retinal detachment

Ashish Bedarkar, Ratnesh Ranjan, Perwez Khan, Ramesh Chandra Gupta, Rajnath Kushwaha, Shalini Mohan

**Abstract:**

**PURPOSE:** This study was aimed to evaluate the difference in the ocular parameter changes following scleral buckling (SB) for rhegmatogenous retinal detachment (RRD) in different age group patients.

**MATERIALS AND METHODS:** This prospective study included 26 eyes of 26 patients who underwent SB for uncomplicated RRD. The patients were divided into three age groups: 16–30 years (Group I), 31–45 years (Group II), and 46–60 years (Group III). Axial length (AL), anterior chamber depth (ACD), and corneal curvatures were measured preoperatively and postoperatively at 1 week, 1 month, and 3-month. The postoperative change and progression of these parameters were evaluated and compared between three age groups using nonparametric Wilcoxon signed-rank test and Kruskal–Wallis test.

**RESULTS:** At 3-month follow-up, a statistically significant postoperative AL increase, ACD decrease, and surgically induced astigmatism (SIA) were observed in all groups (Group I - 0.75 ± 0.32 mm, 0.21 ± 0.21 mm, and 1.5 ± 0.48 D, respectively; Group II - 0.79 ± 0.41 mm, 0.14 ± 0.04 mm, and 2.07 ± 1.18 D, respectively; Group III - 0.86 ± 0.33 mm, 0.16 ± 0.05 mm, and 1.56 ± 1.19 D, respectively). However, surgery-induced change for any parameter was not significantly different between the groups ($P$ for AL [0.7955]; ACD [0.8805]; and SIA [0.5485]). Progression in postoperative changes in AL and ACD was insignificant during three follow-up examinations in all the groups. However, SIA of Group I continued to change significantly up to 3 months but stopped to change at 1 month only in Group II and III.

**CONCLUSION:** Age-related change in physical properties of ocular tissue does not have any major additional effect on the results of SB except that the postsurgical change in corneal curvature stops earlier in older patients compared to that in younger patients.

**Keywords:**

Anterior chamber depth, axial length, corneal astigmatism, scleral buckle, surgically induced astigmatism

*Department of Ophthalmology, GSVM Medical College, Kanpur, Uttar Pradesh, India*

**Address for correspondence:**
Dr. Ratnesh Ranjan, Aravind Eye Hospital, Avinashi Road, Coimbatore - 641 014, Tamil Nadu, India.
E-mail: drratnesh16@gmail.com

Submission: 10-06-2016
Accepted: 02-10-2016

## Introduction

Scleral buckling (SB) with an episcleral exoplanet was first performed as a technique to repair rhegmatogenous retinal detachment (RRD) by Custodis in 1949 and since then it was the only significant treatment alternative for RRD until the introduction of pars plana vitrectomy (PPV) in the early 1970s.[1] Although the success rate of retinal attachment is much higher with the modern techniques of PPV and internal tamponade, conventional SB is still considered to be a safe and effective technique in the primary management of uncomplicated RRD with the overall success rate ranging from 82% to 92%.[2] In most of



**How to cite this article:** Bedarkar A, Ranjan R, Khan P, Gupta RC, Kushwaha R, Mohan S. Scleral buckling-induced ocular parameter changes in different age group patients of rhegmatogenous retinal detachment. Taiwan J Ophthalmol 2017;7:94-9.

the developing countries, where the treatment of RRD has a low priority due to overburden of other causes of blindness, SB is still the most commonly performed surgery for RRD due to lack of facilities for the modern surgical management and very low level of training and equipment.[3]

The SB works in part by favorably altering the geometry of the eye, which helps in closure of breaks and its maintenance. In many studies, it has been observed that SB causes changes in the shape and stress distribution of the scleral shell resulting in a reduction of ocular rigidity.[4,5] This change in the geometry and the rigidity of the eyeball results in a number of the clinically important secondary effects including change in the axial length (AL) and volume of the eyeball, change in the anterior chamber depth (ACD), and change in the corneal curvatures, i.e., surgically induced astigmatism (SIA). Alteration in ocular rigidity due to buckling depends on type and material of buckle, location and height of buckle, and the tension of the scleral suture.[6,7]

On the other hand, aging is an ongoing process, which also affects ocular rigidity by alterations in biochemical properties of the ocular tissue matrix.[8] Age-related increase in ocular rigidity affects several ocular parameters such as scleral rigidity and compliance, central corneal thickness, and elasticity, which are very important for maintaining the ocular physiology and optics.[8-11]

This study was conducted with the aim to evaluate the changes in various ocular parameters known to occur following SB procedure in patients with RRD and to evaluate the difference in these changes in different age groups due to age-related alterations in ocular rigidity.

## Materials and Methods

A prospective study was performed during a period from January 2011 to June 2012, in which all patients of age ranging from 16 to 60 years admitted for RRD surgeries in the retina unit of ophthalmology department of a tertiary health-care center were enrolled in the study. The study was conducted in full accordance with principles in the Declaration of Helsinki. This study included 26 eyes of 26 patients who underwent SB surgeries and reported for recommended follow-up examinations during the period of study. The study included patients with uncomplicated, macula-off RRD with single primary break noted preoperatively. Patients with multiple breaks, any ocular pathology other than RRD, and history of any previous ocular surgery were excluded from the study. Written informed consents were taken from all the patients.

To assess the difference in various ocular parameter changes in the patients of different age groups undergoing SB procedure, the patients were divided into three groups: 16–30 years (Group I), 31–45 years (Group II), and 46–60 years (Group III). After taking detailed history from all the patients, the parameters evaluated preoperatively were AL and ACD measured by ultrasound A-scan instrument (Biomedix A Scan, India), and keratometric value was measured by autorefracto-keratometer (URK-700, UNICOS, Korea).

All surgeries were performed by a single surgeon (Perwez Khan) under local anesthesia by peribulbar injection of 6 ml of 2% xylocaine and 2 ml of 0.5% bupivacaine. All eyes with RRD underwent SB procedure. First, the break was localized and then sealed by cryotherapy, followed by subretinal fluid (SRF) drainage, if needed. Same silicon band of style 276 (Labtician Ophthalmics, Inc., Oakville, Canada) was used for circumferential segmental buckling (one quadrant) in all patients depending on the location of break in individual cases. For segmental buckle (style 276), the main indentation over the retinal break was produced by applying scleral sutures with a bed of 2 mm wider than the buckle width and tightened temporarily to provide optimal width and height. If intraocular pressure remained low and the break was in optimal position, the sutures were tied permanently. Radial buckle was not used in any eye. Encircling element of style 240 (Labtician Ophthalmics, Inc., Oakville, Canada) was used in all the eyes undergoing SB to produce only mild or no visible scleral indentation with a 6–8 mm shortening in length of encircling element.

The intraoperative details including the location of break, the nature of surgery, size of the buckle and encircling element, the location of sutures applied to secure them and drainage of SRF were recorded. Postoperative treatment included topical moxifloxacin 0.5% QID, topical prednisolone 1% QID, and topical homatropine 2% TDS. Postoperatively, patients were examined at 1 week, 1 month, and 3-month interval. During follow-up examinations, all the parameters, which were noted preoperatively, were noted again in a similar manner. SIA was also calculated using SIA Calculator software.

The data of all the patients were managed on an Excel Spreadsheet. Preoperative and postoperative measurements in the three age groups were summarized by mean ± standard deviation. Considering the small sample size, nonparametric tests were used for statistical evaluation. Changes in all parameters following surgery within each group at 3-month follow-up were assessed using Wilcoxon signed-rank test. Postoperative progressions of these parameters in the three age groups were also assessed by comparing their values at 1 week, 1 month, and 3-month follow-up. Comparative analysis of surgery-induced change in various ocular parameters between three groups was done using Kruskal–Wallis test. A $P < 0.05$ was considered statistically significant.

## Results

The mean age of the patients was 39.46 ± 13.56 years, and majority (85%) of the patients ($n = 26$) were males. However, the mean age of the three study groups were 22.57 ± 4.86 years (Group I), 38.55 ± 5.30 years (Group II), and 55.50 ± 3.96 years (Group III). The physical and ocular characteristics of the study groups have been summarized in Table 1.

The mean preoperative AL in Group I, II, and III was 25.07 ± 2.20 mm, 24.11 ± 1.68 mm, and 22.63 ± 3.04 mm, respectively, which increased significantly to 25.82 ± 1.98 mm, 24.89 ± 1.48 mm, and 23.49 ± 2.79 mm, respectively, at 3-month follow-up. The mean increase in AL at 3-month follow-up for all patients was 0.80 ± 0.34 mm. The mean increases in AL following surgery was 0.75 ± 0.32 mm for Group I, 0.79 ± 0.41 mm for Group II, and 0.86 ± 0.33 for Group III. Comparative analysis of AL increase following surgery between groups showed no statistically significant difference ($P = 0.7955$) [Table 2].

A statistically significant postoperative decrease was recorded in the mean ACD in all the three groups. In Group I, II, and III, preoperative ACD was recorded as 3.45 ± 0.23 mm, 3.65 ± 0.72 mm, and 3.35 ± 0.57 mm, respectively, and decreased postoperatively to 3.23 ± 0.40 mm, 3.51 ± 0.74 mm, and 3.19 ± 0.59 mm, respectively, at 3 months. The mean decrease in ACD following surgery was 0.21 ± 0.21 mm, 0.14 ± 0.04 mm, and 0.16 ± 0.05 mm for Group I, II, and III, respectively, and comparative analysis between groups was not statistically significant ($P = 0.8805$) [Table 2].

The mean corneal astigmatism in Group I, II, and III increased significantly from preoperative 0.51 ± 0.47D, 2.05 ± 1.82D, and 1 ± 0.89D to postoperative 2.04 ± 0.51D, 3.18 ± 1.34D, and 2.56 ± 1.50D, respectively, at 3-month follow-up. The mean difference between preoperative and postoperative corneal astigmatism, i.e., mean SIA of the three groups was analyzed comparatively with each other and was not found to be statistically significant ($P = 0.5485$) [Table 2].

In addition, there was no significant change in the AL and ACD during three follow-up examinations at 1 week, 1 month, and 3-month in all the three groups. However, a significant difference in change in SIA was seen in all the three groups. In Group I, SIA continued to change significantly till 3-month follow-up, while it stopped to progress only after 1 month in Group II and III [Table 3].

## Discussion

The important predisposing factors for RRD include increasing age, male gender, myopia, certain vitreoretinal degenerations, posterior vitreous detachment (PVD), ocular trauma, family history, and intraocular surgery.[12-15] In this study, we found a male predilection with 85% of the patients being male ($n = 22/26$). A similar finding of very high male preponderance in developing country was reported by Jamil *et al*.[14] More than two-thirds of RRD patients were above 30 years of age in our study. Li and Beijing Rhegmatogenous Retinal Detachment Study Group also found that RRD is more frequent in the middle-aged or elderly population.[16] The most common location of RRD in our study was superotemporal quadrant followed by superonasal and inferior quadrants. Only two patients had funnel-shaped RRD. Jamil *et al*. reported that superotemporal and inferotemporal were the most commonly involved quadrants,[14] while Mitry *et al*. found superotemporal retina as the most common location for PVD-associated RRD and inferotemporal as the most common quadrant for non-PVD RRD.[13]

**Table 1: Physical and ocular characteristics of study sample**

| Physical/ocular characteristics | Number of patients (%) | Mean±SD |
|---|---|---|
| Age (years) | | |
| Group I (16-30 years) | 7 (26.92) | 22.57±4.86 |
| Group II (31-45 years) | 11 (43.31) | 38.55±5.30 |
| Group III (46-60 years) | 8 (30.77) | 55.50±3.96 |
| Sex | | |
| Male | 22 (84.62) | |
| Female | 4 (15.38) | |
| Location of retinal break | | |
| Superotemporal | 8 (30.77) | |
| Superonasal | 6 (23.08) | |
| Inferior (6 o'clock) | 5 (19.23) | |
| Inferotemporal | 3 (11.54) | |
| Inferonasal | 2 (7.69) | |
| Superior (12 o'clock) | 2 (7.69) | |
| Extent of RRD | | |
| Four quadrants | 8 (30.77) | |
| Three quadrants | 10 (38.46) | |
| Two quadrants | 5 (19.23) | |
| Single quadrant | 3 (11.54) | |
| AL (mm) | | |
| <22 | 4 (15.38) | |
| 22-26 | 17 (65.38) | |
| >26 | 5 (19.23) | |

RDD = Rhegmatogenous retinal detachment, AL = Axial length, SD = Standard deviation

**Table 2: Preoperative and postoperative readings of ocular parameters in three age groups**

| Ocular parameters | Group | Mean±SD | | | Wilcoxon signed-rank test (*W* value)* Significance result at $P \leq 0.05$ | Kruskal-Wallis test (intergroup comparative analysis) |
|---|---|---|---|---|---|---|
| | | Preoperative reading | Postoperative reading at 3-month | Difference | | |
| AL (mm) | I | 25.07±2.20 | 25.82±1.98 | 0.75±0.32 | S | *P*=0.7955 |
| | II | 24.11±1.68 | 24.89±1.48 | 0.79±0.41 | S | |
| | III | 22.63±3.04 | 23.49±2.79 | 0.86±0.33 | S | |
| ACD (mm) | I | 3.45±0.23 | 3.23±0.40 | 0.21±0.21 | S | *P*=0.8805 |
| | II | 3.65±0.72 | 3.51±0.74 | 0.14±0.04 | NS | |
| | III | 3.35±0.57 | 3.19±0.59 | 0.16±0.05 | S | |
| Corneal astigmatism (diopter) | I | 0.51±0.47 | 2.04±0.51 | 1.5±0.48 | S | *P*=0.5485 |
| | II | 2.05±1.82 | 3.18±1.34 | 2.07±1.18 | S | |
| | III | 1±0.89 | 2.56±1.50 | 1.56±1.19 | S | |

*Accurate *P* value for *Z* value could not be calculated due to small sample size; hence, significance of Wilcoxon signed-rank test result was calculated for *W* value with level of significance at $P \leq 0.05$. AL = Axial length, ACD = Anterior chamber depth, S = Statistically significant, NS = Statistically not significant, SD = Standard deviation

**Table 3: Postoperative changes in different ocular parameters in the three groups**

| Ocular parameters | Group | Postoperative readings | | | Wilcoxon signed-rank test (*W* value)* Significance result at $P \leq 0.05$ | |
|---|---|---|---|---|---|---|
| | | 1 week (A) | 1 month (B) | 3-month (C) | A versus B | B versus C |
| AL (mm) | I | 25.76±1.94 | 25.87±2.00 | 25.82±1.98 | NS | NS |
| | II | 24.84±1.47 | 24.85±1.40 | 24.89±1.48 | NS | NS |
| | III | 23.45±2.77 | 23.43±2.78 | 23.49±2.79 | NS | NS |
| ACD (mm) | I | 3.20±0.39 | 3.19±0.41 | 3.23±0.40 | NS | NS |
| | II | 3.48±0.73 | 3.49±0.74 | 3.51±0.74 | NS | NS |
| | III | 3.18±0.59 | 3.18±0.57 | 3.19±0.59 | NS | NS |
| SIA (diopter) | I | 2.68±0.96 | 2.14±0.79 | 1.5±0.49 | S | S |
| | II | 2.89±1.20 | 2.25±1.15 | 2.07±1.18 | S | NS |
| | III | 2.41±1.17 | 1.78±1.18 | 1.56±1.19 | S | NS |

*Accurate *P* value for *Z* value could not be calculated due to small sample size; hence, significance of Wilcoxon signed-rank test result was calculated for *W* value with level of significance at $P \leq 0.05$. AL = Axial length, ACD = Anterior chamber depth, SIA = Surgically induced astigmatism, NS = Statistically not significant, S = Statistically significant

SB procedure, a conventional method of surgical management for RRD, is well known to alter various ocular parameters including increase in AL, decrease in ACD, and to induce surgical astigmatism. In accordance with the results of many previous studies, we also found an increase in AL, flattening of anterior chamber, and a clinically significant SIA.

During SB procedure, tightening of circumferential encircling element around the equator of the eye results in an increase in anteroposterior diameter of the eyeball, which predominates over decrease in AL resulting from scleral invagination by tightening the mattress suture around a circumferential hard silicone exoplanet. Similar to other studies,[17-19] we also found a statistically significant increase in AL of the eyeball in all the three age groups as 0.75 mm, 0.79 mm, and 0.86 mm, respectively, at 3-month follow-up, without any significant progressive change in AL during three follow-up examinations. Zhu *et al*. also evaluated the preoperative and postoperative axial diameter and found a statistically significant increase in AL of 0.67 mm ($P$ = 0.000).[18] However, no significant difference in AL increase was noted between the three age groups in the present study.

AC flattening following SB results from forward shifting of the lens-iris diaphragm and increase in the lens thickness.[20] Hence, ACD decrease is more prominent in phakic eyes as compared to aphakic eyes. In our study, all the patients were phakic, and there was a significant decrease in ACD of 0.21 mm, 0.14 mm, and 0.16 mm in all the three age groups, respectively, at 3-month follow-up. However, there was no significant progressive change in ACD at 1 week, 1 month, and 3-month follow-up examinations for any age group. In addition, intergroup comparison of ACD decrease at 3 months showed insignificant difference. A similar decrease in ACD has been reported by Goezinne *et al*.[19] and Karti *et al*.[21] Karti *et al*. evaluated ACD and iridocorneal angle (ICA) with anterior segment optical coherence tomography following SB surgery and found ACD shallowing and ICA narrowing postoperatively with persistence of ACD shallowing even after 6 months, but ICA returned to preoperative level within 6 months.[21] However, Goezinne *et al*. found that ACD returned to original at 1 year after surgery.[19]

Corneal astigmatism following SB surgery is more likely to result from the placement of segmental and radial buckle. Some astigmatic error may become persistent requiring refractive correction. In accordance with other studies evaluating SIA following SB procedure,[18,22] we also found a clinically significant SIA at 3-month follow-up in all the three age groups; however, it was not statistically significant in Group II. Although there was no statistically significant difference between the SIA of three age groups at 3-month follow-up, SIA continued to change significantly up to 3 months postoperatively in the first age group (16–30 years), while it stabilized at 1 month follow-up with no significant subsequent change in the rest of the two groups. Müller-Albach *et al.* also found that in patients who underwent SB with encircling element SIA did not change significantly after 1 month of postoperative period.[22]

With age-related alterations in the biochemical properties of the ocular matrix, ocular rigidity increases significantly with aging and affects several ocular parameters.[8] According to Friedman's theory, the sclera becomes increasingly more rigid and noncompliant with aging.[9] However, in our study, we did not found any additional effect of age-related increase of the scleral rigidity on the changes in AL and ACD induced by buckling procedure. Aging process also affects the corneal elasticity and thickness. In an experimental study on organ cultured human corneoscleral buttons, Knox Cartwright *et al*. found an increase in the stiffness of the human cornea with age by a factor of approximately two between the ages of 20 and 100 years.[11] The age-related stiffening of cornea results due to increases in Young's modulus,[11] the ocular rigidity coefficient,[8] and cohesive tensile strength.[10] Accordingly, we also noticed that in patients below 30 years of age, buckling-induced change in corneal curvatures continued to occur significantly till 3-month follow-up, while that in patients above 30 years of age ceased after 1 month postoperatively. This additional effect of the age on the corneal changes induced by buckling can be explained by decreasing molding nature of cornea with age-related stiffening.

A small sample size is the main limitation of this study. Another limitation of this study is that RRD itself might slightly alter some parameters from preoperative original status of patients such as AL measurement due to macula-off RRD or refractive status due to change in intraocular pressure.

## Conclusion

The results of this study, however, supports the findings of the previous studies in terms of SB-induced changes in ocular parameters but do not show any major additional effect of age-related change in physical properties of ocular tissue except that the postsurgical change in corneal curvature stops earlier in older patients as compared to that in patients younger than 30 years of age. A future study involving greater number of patients may show more interesting results.


### Financial support and sponsorship
Nil.


### Conflicts of interest
The authors have no any conflicts of interest to declare.

## References


1. Ryan EH Jr., Mittra RA. Scleral buckling vs. vitrectomy: The continued role for scleral buckling in the vitrectomy era. Arch Ophthalmol 2010;128:1202-5.
2. Khanzada MA, Wahab S, Hargun LD. Impact of duration of macula off rhegmatogenous retinal detachment on visual outcome. Pak J Med Sci 2014;30:525-9.
3. Khan MT, Jan S, Karim S, Iqbal S, Saeed N. Outcome of scleral buckling procedures for primary rhegmatogenous retinal detachment. J Pak Med Assoc 2010;60:754-7.
4. Friberg TR, Fourman SB. Scleral buckling and ocular rigidity. Clinical ramifications. Arch Ophthalmol 1990;108:1622-7.
5. Johnson MW, Han DP, Hoffman KE. The effect of scleral buckling on ocular rigidity. Ophthalmology 1990;97:190-5.
6. Whitacre MM, Emig MD, Hassanein K. Effect of buckling material on ocular rigidity. Ophthalmology 1992;99:498-502.
7. Hayashi H, Hayashi K, Nakao F, Hayashi F. Corneal shape changes after scleral buckling surgery. Ophthalmology 1997;104:831-7.
8. Pallikaris IG, Kymionis GD, Ginis HS, Kounis GA, Tsilimbaris MK. Ocular rigidity in living human eyes. Invest Ophthalmol Vis Sci 2005;46:409-14.
9. Friedman E. The role of the atherosclerotic process in the pathogenesis of age-related macular degeneration. Am J Ophthalmol 2000;130:658-63.
10. Elsheikh A, Wang D, Brown M, Rama P, Campanelli M, Pye D. Assessment of corneal biomechanical properties and their variation with age. Curr Eye Res 2007;32:11-9.
11. Knox Cartwright NE, Tyrer JR, Marshall J. Age-related differences in the elasticity of the human cornea. Invest Ophthalmol Vis Sci 2011;52:4324-9.
12. Mitry D, Charteris DG, Fleck BW, Campbell H, Singh J. The epidemiology of rhegmatogenous retinal detachment: Geographical variation and clinical associations. Br J Ophthalmol 2010;94:678-84.
13. Mitry D, Singh J, Yorston D, Siddiqui MA, Wright A, Fleck BW, *et al.* The predisposing pathology and clinical characteristics in the Scottish retinal detachment study. Ophthalmology 2011;118:1429-34.
14. Jamil MH, Farooq N, Khan MT, Jamil AZ. Characteristics and pattern of rhegmatogenous retinal detachment in Pakistan. J Coll Physicians Surg Pak 2012;22:501-4.
15. Van de Put MA, Hooymans JM, Los LI; Dutch Rhegmatogenous Retinal Detachment Study Group. The incidence of rhegmatogenous retinal detachment in the Netherlands. Ophthalmology 2013;120:616-22.
16. Li X; Beijing Rhegmatogenous Retinal Detachment Study Group. Incidence and epidemiological characteristics of rhegmatogenous retinal detachment in Beijing, China. Ophthalmology 2003;110:2413-7.

17. Citirik M, Batman C, Acaroglu G, Can C, Zilelioglu O, Koc F. Analysis of changes in corneal shape and bulbus geometry after retinal detachment surgery. Int Ophthalmol 2004;25:43-51.
18. Zhu ZC, Ke GJ, Wen YC, Wu ZY. Effects of scleral encircling surgery on vitreous cavity length and diopter. Int J Ophthalmol 2016;9:572-4.
19. Goezinne F, La Heij EC, Berendschot TT, Tahzib NG, Cals DW, Liem AT, *et al.* Anterior chamber depth is significantly decreased after scleral buckling surgery. Ophthalmology 2010;117:79-85.
20. Huang C, Zhang T, Liu J, Tan R, Qiang Ji MM. Changes in axial length and anterior chamber depth after rhegmatogenous retinal detachment repair. J Clin Exp Ophthalmol 2014;5:377.
21. Karti O, Selver OB, Ozbek Z, Oner FH, Durak I, Saatci AO. Evaluation of corneal thickness, anterior chamber depth, and iridocorneal angle following scleral buckling surgery with AS-OCT. Ophthalmic Surg Lasers Imaging 2012;43 6 Suppl: S97-102.
22. Müller-Albach KA, Dick B, Pavlovic S. Changes in bulbus geometry after conventional detachment surgery. Study using video keratoscopy. Ophthalmologe 1995;92:677-80.