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Intraocular Pressure, Axial Length and Anterior Chamber Depth Changes after Scleral Buckling

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ABSTRACT

Background: A rhegmatogenous retinal detachment (RD) involves pathologic separation of the neural retina from the pigment epithelium because of a hole or break in the retina. Rhegmatogenous RD leads to the loss of visual function and requires prompt surgical therapy.

Objective: Study of the axial length (AL) and anterior chamber depth (ACD) following scleral buckling (SB) for rhegmatogenous retinal detachments (RRD), may help to isolate the preoperative susceptible cases for intraocular pressure (IOP) variations, explain cause of postoperative IOP changes and find a way to optimize postoperative management of these changes.

Patients and Methods: The study was a prospective cohort of 28 patients for whom SB surgery was operated at the Department of Ophthalmology, Zagazig University, Egypt between April 2019 and October 2019. The patients were divided into two groups depending on the extent of scleral buckle used. Group one (encircling group) included patients with RRD indicated for encircling (360˚) scleral buckle. Group two (segmental group) included patients with RRD indicated for segmental circumferential (less than 360˚) scleral buckle.

Results: After placement of encircling buckles at 1 month, IOP (in mmHg) increased from 14 ± 1.18 to 27.64±4.77, ACD (in mm) decreased from 3.66±0.41 to 3.40±0.44 and AL (in mm) increased from 25.56±3.52 to 26.04±0.44 while after placement of segmental buckles, IOP increased from 14 ± 1.24 to 15.79 ± 2.69, ACD decreased from 3.69±0.28 to 3.63±0.26 and AL increased from 25.56±1.30 to 25.65±1.27 at 1 month.

Conclusion: The study revealed that scleral buckling (either encircling or segmental circumferential) induced increase in AL and decrease in ACD.

Keywords: ACD, Axial length, Index terms, Rhegmatogenous retinal detachment, Scleral buckling.

INTRODUCTION

Rhegmatogenous retinal detachment (RRD) occurs when a break in the retina leads to fluid accumulation with a separation of the neurosensory retina from the underlying retinal pigment epithelium [1]. This is the most common type of retinal detachment[2]. RRD is regarded as an ocular emergency that needs immediate treatment[3]. Techniques for the surgical management of RRD include pneumatic retinopexy, scleral buckling, pars plana vitrectomy, alone or in combination[4].

Scleral buckle(SB) surgery is an established, safe, successful and the procedure of choice in uncomplicated RRD especially in young, phakic, myopic patients[5,6] with inferior breaks as it saves the crystalline lens in comparison to the high incidence of cataract developing after pars plana vitrectomy[7]. Advantages of this technique are better postoperative best corrected visual acuity, low morbidity, slight reaction to intraocular inflammation and lack of serious intraoperative and postoperative complications. These advantages occur due to the minimally invasive and extraocular nature of this procedure[8].

Scleral buckling causes refractive changes and change in the axial length of the globe depending on many variables chiefly the type of buckle, the height of the buckling effect and the circumferential extent of the buckle. Radial scleral buckles do not induce significant refractive changes even when the buckling effect extents anteriorly to the ora serrate. On the contrary, encircling scleral buckles cause an average increase in axial length of 0.99 mm and an average myopic shift of 2.75 diopters[9].

Goezinne *et al.*[8] measured the anterior chamber depth and axial length of the eye globe after encircling scleral buckles using anterior segment-optical coherence tomography and IOL Master and reported that the anterior chamber depth remained decreased and the axial length remained enlarged after scleral buckling for almost 1 year. This was also confirmed by **Kim *et al.*** [10] who found alteration in the shape of the eye by changing axial length and anterior chamber depth following scleral buckling using anterior segment-optical coherence tomography and IOL Master. These changes in anterior chamber depth occurred mainly in the early postoperative period chiefly in the first postoperative week.

Kawana *et al.* [9] by means of ultrasound biomicroscopy, evaluated the ciliary body thickness and anterior chamber depth after scleral buckling procedures, confirming the existence of subclinical ciliary edema for at least 1 month postoperatively that may induce changes in anterior chamber angle.

Kornmann and Gedde[11] showed IOP elevation following scleral buckling in about 1.4 to 4.4% of cases. These elevations may be attributed to impaired venous drainage through the vortex veins by the scleral buckle, leading to congestion and swelling of the ciliary body. As the ciliary body swells, it rotates anteriorly and shifts the lens-iris diaphragm forward. These morphological changes have been demonstrated experimentally and

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can be seen on fundoscopic examination or by ultrasonography and ultrasound biomicroscopy[12, 13].

In this paper, we measured axial length and ACD changes in relation to IOP changes after scleral buckling either circumferential or segmental buckles.

PATIENTS AND METHODS

This prospective cohort study included 28 eyes of 28 patients who underwent successful retinal reattachment surgery in one eye. The surgical procedure was either encircling or segmental circumferential scleral buckling. The procedures were performed at the Department of Ophthalmology, Zagazig University between April 2019 and November 2019. The mean age of the patients was 36.93 ± 13.49 years. There were 19 males (67.9%) and 9 females (32.1%).

Patients were excluded from the study if they showed the following preoperative criteria:

Pre-existing anterior chamber angle abnormalities, patients diagnosed with glaucoma, pseudophakic patients, patients undergoing combined pars plana vitrectomy and scleral buckling, patients with previous history of ocular inflammation, and patients indicated for radial scleral buckling.

Patients were divided into two equal groups, 14 patients each, according to the type of scleral buckle used in the reattachment surgery: Group 1: Included patients treated with encircling buckles, and **Group 2:** Included patients treated with segmental circumferential buckles.

Preoperative evaluation:

All the patients included in the present study were subjected to the following preoperative ophthalmological examination:

- Careful history taking: patient information (age, sex, occupation and residence), any chronic disease (e.g. diabetes), onset, course and duration of visual loss.
- Visual acuity: The unaided, best corrected visual acuity using Snellen chart.
- Slit lamp biomicroscopy of the anterior segment.
- Fundus examination using indirect ophthalmoscope and slit lamp biomicroscopy for assessment of the retina, optic nerve and macula.
- IOP measurement under mydriasis with Goldmann applanation tonometer for both eyes.
- Measurement of AC depth and axial length using IOL Master 500 device (Carl Zeiss Meditec, Berlin, Germany).

Procedure:

On the day of surgery, all patients received short-acting mydriatic agents (tropicamide 0.5%, cyclopentolate 1.0%) for pupil dilation. Retinal reattachment procedure was done under general anesthesia for all patients.

In all the operated upon eyes, an exoplant was used; either a 360˚ #240 band incorporated with a segment of a #287 tire or a circumferential silicone sponge (oval sponge style # 506 Labtician Ophthalmics Inc., Oakville, Canada) extending between 90˚ and 180˚ beneath the recti muscles. The buckles were fixed to the sclera by 5/0 polyester sutures.

The following variables were recorded during the operation: (1) Type and extent of scleral buckle used. (2) Drainage of subretinal fluid or not. (3) Number of cryo-application. (4) AC paracentesis was performed or not. (5) Injection of intravitreal air or not. (6) Whether the case received mannitol or acetazolamide tablets postoperatively or not.

Follow-up and Assessments:

Postoperatively, patients received: Topical antibiotic eye drops 5 times daily for two weeks. Topical steroid drops 5 times daily for three weeks. Topical short acting mydriatic 3 times daily for three weeks. All the patients were scheduled for regular postoperative follow up. IOP, ACD and axial length were measured at one month after the operation

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation and participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, entered, and analyzed by computer using a data base software program, Statistical Package for the Social Sciences (SPSS) (Version 20.0. Armonk, NY: IBM Corp). Qualitative data were represented as frequencies and percentages. For quantitative variables mean ± standard deviation (SD) were used to represent data. Independent t-test (t) was used for detection of difference between different quantitative variables, while nonparametric data was evaluated with Mann-Whitney U test. For evaluating different quantitative variables in the same group, paired t-test was used. P value < 0.05 was considered significant.

RESULTS

The mean age of the patients included in the study was 36.93 ± 13.49. There were 19 males and 9 females patients. Analysis included 28 eyes treated successfully by SB. Table 1 summarizes intraoperative and postoperative characteristics of the study population.

Table (1): Distribution of the studied participants to intraoperative and postoperative characteristics (n=28)

Characteristics	(n=28) No	%
Extent of buckle per degree		
• 180	11	39.3
• 270	3	10.7
• 360	14	50
Drainage of subretinal fluid		
• Yes	13	46.4
• No	15	53.6
Number of cryo-application		
• 1	5	17.9
• 2	6	21.4
• 3	13	46.4
• 4	4	14.3
Paracentesis		
• Yes	6	21.4
• No	22	78.6
Intraoperative gas injection		
• Yes	3	10.7
• No	25	89.3
PVR grading		
• No	21	75
• Grade A	4	14.3
• Grade B	3	10.7
Postoperative mannitol or acetazolamide		
• Yes	12	42.9
• No	16	57.1

Effect of encircling buckles on the intraocular pressure: After placement of encircling buckles, IOP increased significantly (Table 2).

Table (2): Changes in IOP in the encircling group preoperative and after 1 month

Variables	Preoperative (n=14)	1 month postoperatively (n=14)	P value
IOP (mmhg) Mean± SD	14 ± 1.18	27.64 ± 4.77	**<0.001****

Effect of encircling buckles on the AC depth and axial length of the operated on eyes: When comparing the ACD in the operated on eyes of the encircling group, there was highly significant decrease at 1 month as compared to the preoperative value. When comparing the axial length in the operated on eyes of the encircling group, there was significant increase at 1 month as compared to the preoperative value (Table 3).

Table (3): Change of AC depth and axial length over time in the encircling group

Variable	Preoperative (n=14) Mean ± SD	1 month postoperatively (n=14) Mean ± SD	P value
ACD in mm	3.66±0.41	3.40±0.44	<0.001
AL in mm	25.56±3.52	26.04±0.44	0.026

Effect of segmental buckles on the intraocular pressure: After placement of segmental buckles, IOP increased from 14 ± 1.24 to 15.79 ± 2.69 at 1 month (Table 4).

Table (4): Changes in IOP in the segmental buckles group

Variables	Preoperative (n=14)	1 month postoperatively (n=14)	P-value
IOP (mmhg) Mean± SD	14 ± 1.24	15.79 ± 2.69	**0.044**

Effect of segmental buckles on the AC depth and axial length of the operated on eyes: When comparing the ACD in the operated on eyes of the segmental group, there was significant decrease at 1 m as compared to the preoperative value. When comparing the axial length in the operated eyes of the segmental group, there was significant increase at 1 m as compared to the preoperative value (Table 5).

Table (5): change of AC depth over time in the segmental group

Variable	Preoperative (n=14) Mean ± SD	1 month postoperatively (n=14) Mean ± SD	P value
ACD in mm	3.69±0.28	3.63±0.26	0.006
AL in mm	25.56±1.30	25.65±1.27	0.004

Comparison of the study variables in the two groups:

Comparison of IOP in the two groups:

when comparing IOP between the two groups, there was no significant difference preoperatively. After 1 month, there was significant increase in the encircling group more than the segmental group (Table 6).

Table (6): IOP changes comparison between the two groups

Variables	Group 1 (n=14) Mean ± SD	Group 2 (n=14) Mean ± SD	P value
Preoperative IOP (mmHg)	14 ± 1.18	14 ± 1.24	1.00
Postoperative IOP (mmHg)	27.64 ± 4.77	15.79 ± 2.69	**<0.001****

Comparison of ACD in the two groups: When comparing ACD between the two groups, there was no significant difference preoperatively and at 1 month (Table 7).

Table (7): Comparison of the two groups regarding ACD

ACD	Group 1 (n=14) Mean ± SD	Group 2 (n=14) Mean ± SD	P value*
Preoperative	3.66±0.41	3.69±1.30	0.992
1 month	3.40±0.44	3.63±0.26	0.111

Comparison of axial length in the two groups: When comparing ACD between the two groups, there was no significant difference preoperatively and at 1 month (Table 8).

Table (8): comparison of the two groups regarding axial length

Axial length	Group 1 (n=14) Mean ± SD	Group 2 (n=14) Mean ± SD	P value
Preoperative	25.56±3.52	25.56±1.30	1
1 month	26.04±3.50	25.65±1.27	0.704

DISCUSSION

Scleral buckling surgery is a known risk factor for IOP elevation and further glaucomatous damage [(11)]. The incidence of angle closure following SB procedure has been estimated to be 1.4% to 4.4 % [(14)]. More than one mechanism have been used to explain such IOP changes, the most important of which is the morphological changes that occur in the ciliary body which swells as a consequence of impaired venous drainage through vortex veins with supraciliary effusions[(13,15)] in about 33% to 100% of cases. Anterior rotation of the ciliary body [(16)] follows its swelling, which induces narrowing of the AC angle elevating IOP. These changes were reported experimentally and proved by imaging techniques like ultrasound biomicroscopy (UBM) [(14-17)].

Another mechanism is that SB compresses the vitreous which causes forward displacement of iris-lens diaphragm leading to shallow AC which contributes to the IOP elevations [(13,17)]. Several factors have been associated with IOP elevation after SB including use of encircling band[(14)], excessive cryo-applications[(18)], large retinal break[(15,17)], high myopia, older age and previous angle narrowing[(19)].

In our study, we documented the change in IOP, axial length and anterior chamber depth after scleral buckling either encircling or segmental. In the encircling group, IOP increased from 14 ± 1.18 to 27.64 ± 4.77 at 1 month while in the segmental group, IOP increased from 14 ± 1.24 to 15.79 ± 2.69 at 1 month.

Khanduja *et al.* [(20)] reported that the mean IOPs (using applanation tonometry) were 12.68±1.96 mm Hg (preoperatively), 17.04±3.26 mm Hg (48 hours), 13.4±2.36 mm Hg (1 week), and 11.78±1.26 mm Hg (1 month), respectively. The IOP at 48 hours was significantly higher than that at the preoperative level. Six (10.9%) eyes had an IOP>22 mm Hg at 48 hours, whereas 14 eyes (25.4%) had an increase in IOP of 5 mm Hg or more. The highest IOP recorded was 28 mm Hg and the maximum increase from baseline was 16 mm Hg. No significant difference was noted between the preoperative IOP and the IOP readings at 1 week and 1 month after surgery. The IOP at 48 hours and 1 week was significantly higher in eyes with 180-degree buckle compared with eyes with 90 and 135 degree buckles.

Goezinne *et al.* [(8)] stated that at the first postoperative day, mean IOP was significantly higher in treated eyes compared with the preoperative value (19.4±5.4 mmHg vs. 14.2±3.7 mmHg, respectively). Mean IOP was not significantly different at 1 week or at 1, 3, 6, 9, and 12 months after SB surgery. None of the eyes developed a secondary angle-closure glaucoma. Only at the first postoperative day, mean IOP of the treated eye was significantly higher compared with the preoperative situation in eyes that received gas compared with eyes that did not receive gas. In addition, at 1 day postoperatively, mean IOP was significantly higher (19.6±4.9 mmHg vs. 13.3±3.9 mmHg) in eyes that did not receive acetazolamide.

Kawana *et al.* [(9)] showed that intraocular pressure at 3 days after surgery (17.1±5.25 mmHg) was significantly higher than the preoperative level (13.3±2.7 in the buckling (segmental) group and 14.0±3.0 in the encircling group. Three eyes in the buckling group and 3 eyes in the encircling group were treated with oral acetazolamide.

IOP values in our study are in line with the findings of other papers in that most of IOP elevations occurred in the early postoperative periods and were controlled thereafter. Also, IOP values were higher in the encircling than the segmental group.

IOL Master was used to measure the AL and ACD preoperatively and 1 moth postoperatively. In the encircling group, the mean axial length increased significantly from 25.56 ± 3.52 preoperatively to 26.04 ± 3.50 at 1 month (p=0.026) and the mean ACD decreased significantly (p<0.001) from 3.66 ± 0.41 preoperatively to 3.40 ± 0.44 at 1 month. In the segmental group, the mean axial length increased significantly from 25.56 ± 1.30 preoperatively to 25.65 ± 1.27 at 1 weak (p=0.004) and the mean ACD decreased significantly (p=0.006) from 3.69 ± 0.28 preoperatively to 3.63 ± 0.26 at 1 month.

Goezinne *et al.* [8] measured (under mydriasis) the anterior chamber depth and axial length of the eye globe after scleral buckles using anterior segment-optical coherence tomography and IOL Master and reported that the anterior chamber depth remained decreased and the axial length remained enlarged after scleral buckling for 9 months. The mean ACD was 3.33±0.75 mm preoperatively, 2.78±0.71 mm at the first postoperative day, 2.99±0.70 mm at 1 week, 3.05±0.67 at 1 month, 3.07±0.68 mm at 3 months, 3.09±0.71 mm at 6 months, 3.08±0.70 mm at 9 months and 3.160.81 mm at 1 year.

In our study, the changes in AL and ACD at 1 month occurred in line with the findings of **Goezinne *et al.*** [8].

CONCLUSION

Scleral buckling induces elevation of IOP, increase in axil length and decrease of ACD. These changes are more reported with the encircling than the segmental buckles. Shorter eye with encircling buckles are at risk of angle closure glaucoma in the early postoperative period.

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Conflict of Interest: The authors declare no conflict of interest.

Author Contributions: A. Yehya conducted the research, W. Elhaig analyzed the data, A. Saeed and M. Abdulkadir wrote the paper and all authors had approved the final version.

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