Anatomical and Visual Outcomes of Three Different Scleral Buckling Techniques

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Purpose: To compare the anatomical and visual outcomes of three different scleral buckling techniques and to explore the effect of cryotherapy and subretinal fluid drainage (SRFD) on outcomes of surgery.

Methods: This retrospective study was performed on 111 eyes of 109 patients undergoing scleral buckling for rhegmatogenous retinal detachments (RRDs) by a single surgeon. Pre-, intra- and postoperative data were retrieved from hospital records.

Results: Buckles were radial in 27 (24.3%), circumferential (segmental) in 16 (14.4%) and encircling in 68 (61.3%) eyes. Anatomical and visual results were comparable with all three buckling techniques. Application of cryotherapy, the spot number, and SRFD did not affect anatomical and visual results. The only preoperative factor associated with poorer anatomical results was the presence of multiple retinal breaks (P=0.006). The following preoperative factors affected visual outcomes on univariate analysis: extent of retinal detachment (r=0.417, P=0.011) and relative afferent pupillary defect (r=0.423, P=0.02). Preoperative macular status (attached vs detached) also had a significant effect on visual outcomes (P<0.001). Based on multivariate analysis however, only preoperative macular status was significantly correlated with visual results (P=0.022). Silicone sponges placed for non-encircling surgery were removed due to ocular dysmotility in 4 (3.6%) eyes, cosmetic reasons in 3 (2.7%) cases and extrusion in 2 (1.8%) eyes. One encircling tire was also removed due to extrusion.

Conclusion: Surgical technique and performing cryotherapy or SRFD do not seem to influence the anatomical and visual outcomes of scleral buckling. Postoperative complications seem to be more prevalent with non-encircling techniques.

Key words: Scleral Buckling; Retinal Detachment

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INTRODUCTION

Scleral buckling, first described by Schepens,[1] is considered as the standard procedure for repair of rhegmatogenous retinal detachments (RRDs). Although recent years have witnessed a trend toward other interventions such as pneumatic retinopexy and vitrectomy,[1-5] scleral buckling still seems to surpass vitrectomy in the treatment of phakic RRDs.[6]

Scleral buckling includes a variety of techniques including encircling buckles and segmental buckles which can be placed radially, circumferentially or even obliquely. Scleral bu-

ckling has been traditionally combined with subretinal fluid drainage (SRFD) and cryotherapy but none of these routine practices guarantees of a successful outcome.[7-9] Single operation anatomical success rates of up to 92.6% have been reported following scleral buckling for RRD.[10]

Given the diverse condition of eyes requiring buckling surgery, one may customize the procedure according to the number and location of retinal breaks, extent of detachment, grade of proliferative vitreoretinopathy (PVR), and concomitant conditions such as high myopia and pseudophakia. Herein, we compare the anatomical and visual results of three different scleral buckling techniques in a series of patients with RRD operated by a single surgeon.

METHODS

This retrospective study includes a consecutive series of patients who had undergone scleral buckling for repair of RRD by a single surgeon in different eye centers affiliated to Mashhad Medical University from July 2001 to March 2006. Compiled data included sex, age, duration of retinal detachment (RD), status of the fellow eye, preoperative visual acuity, intraocular pressure (IOP), relative afferent pupillary defect (RAPD), lens status, extent of RD, number and type of retinal breaks, and macular status; type of scleral buckling, performing cryotherapy and/or SRFD and intraoperative complications; and postoperative visual acuity, retinal and macular reattachment, postoperative complications, and need for reoperations.

All patients underwent a complete ophthalmologic examination preoperatively and on postoperative visits including determination of Snellen visual acuity which was converted to logMAR notations for statistical purposes, swinging flash light test, slitlamp biomicroscopy, Goldmann applanation tonometry, and dilated fundus examination.

All operations were performed by one surgeon (TB) and surgical technique was selected according to the condition of the eye. The surgeon preferred to place a radial silicone sponge and avoid SRFD whenever possible, and cryotherapy was used sparingly. Segmental circumferential buckles were used in eyes with multiple retinal breaks or when the whole extent of the breaks could not be covered by one or two radial sponges. Encircling buckling was performed only when limited scleral buckling was judged to be inadequate. In cases without visible retinal breaks, the scleral buckle was placed according to Lincoff's rules;[11] encircling buckling was done when the RD was total.

In uncomplicated cases, postoperative examinations were scheduled 1, 21 and 45 days, and 3, 6 and 12 months after surgery. Cases with complications were managed accordingly. Improved vision was considered as at least 0.2 logMAR improvement in visual acuity from baseline. Anatomical success was defined as complete retinal reattachment after the first operation (including pneumatic retinopexy if needed).

Student's *t*-test and ANOVA were used to compare mean values, qualitative variables were compared using the Chi-square test with significance set at 0.05.

RESULTS

During the study period, a total of 111 eyes of 109 patients underwent scleral buckling and were followed for 8.0±9.0 (range 1-60) months. Summarized data are presented in Table 1. Preoperatively, mean visual acuity was 1.78±0.98 (range 0.00-3.00) logMAR and mean IOP was 11.5±4.3 (range 0-29) mmHg which was significantly lower than that of fellow eyes (13.0± 3.4 mmHg, P<0.001). IOP was ≤5 mmHg in 12% and ≤10 mmHg in 21% of eyes; interocular IOP difference exceeded 2 mmHg in 27.4%.

Intraoperative complications included inadvertent globe perforation in 7 eyes, scleral dehiscence due to severe thinning in 3 eyes, mild subretinal hemorrhage in 2 eyes, and vitreous incarceration into the site of SRFD in 2 eyes.

Table 2 summarizes the characteristics of the eyes based on surgical technique. Most localized RRDs were treated by radial or segmental circumferential buckling. Encircling buckling was performed in most cases without visible retinal breaks and in aphakic/pseudophakic eyes. Other preoperative variables were

comparable among eyes undergoing different buckling techniques. Cryotherapy was performed more frequently in eyes undergoing radial buckling as compared to the other 2 groups (Table 3).

Overall, visual improvement of at least 0.2 logMAR was observed in 66.3%, 70%, 74.5%, and 66.7% of eyes 1, 3, 6 and 12 months postoperatively. Mean change in visual acuity was comparable with all three buckling techniques. The rate of complete retinal reattachment was 83.1%, 83.9% and 93.6% at 3, 6 and 12 months (Table 4). Corresponding values for persistent peripheral and total RDs were 14.6%, 9.1% and 3.8%, and 3.1%, 8%, and 2.6% at the same time intervals, respectively.

Table 1 Demographic and clinical data

Male subjects	71 (63.4%)
Age (mean±SD) (yr)	46.9±21.3 (range 10-82)
Right eyes	67 (59.3%)
History of RD in fellow eye	18 (16.5%)
Duration of RD (days)	66.5±145 (range 1-730)
RD duration >1 month	22 (19.8%)
Symptoms	
Decreased vision	82 (83.7%)
Visual field defect	5 (4.4%)
Floaters	3 (2.7%)
Others/mixed	8 (7.2%)
Not documented	14 (12.5%)
Previous history	
High myopia	22 (19.6%)
Cataract surgery	21 (18.75%)
LASIK	3 (2.68%)
Ocular trauma	14 (12.5%)
Extent of RD	
Total	26 (24.8%)
Subtotal	40 (38.1%)
Localized	39 (37.2%)
Not documented	7 (6.3%)
Macular status	
Detached	95 (86.4%)
Not documented	2 (1.9%)
Retinal break(s)*	
Single	56 (60.2%)
Multiple	37 (39.8%)
Type of retinal break(s)	
Horseshoe tear	41 (44%)
Atrophic hole	34 (36.5%)
Dialysis	11 (11.8%)
Mixed type	7 (7.5%)
Not found/documented	19 (17.7%)

SD, standard deviation; RD, retinal detachment; LASIK, laser in situ keratomileusis.
*Preoperative and intraoperative findings.
Note: percentages represent valid figures.

There was no significant difference between eyes with anatomical success (complete retinal reattachment at 6 months) and those with anatomical failure in terms of age, sex, duration of symptoms, laterality of the eye, preoperative visual acuity, IOP, RAPD, extent of RD, visibility of retinal breaks, lens status, macular status and history of retinal detachment in the fellow eye. Although visibility of retinal breaks did not affect anatomical success, mean circumferential extent of the buckle was significantly greater in eyes without visible retinal breaks (P=0.005). Eyes with complete retinal reattachment at 6 months had fewer retinal breaks preoperatively as compared to those without complete reattachment (P=0.006). Performing cryotherapy (P=0.599), the number of cryotherapy applications (P=0.581) and performing SRFD (P=0.528) did not affect the anatomical result.

Univariate analysis revealed that preoperative RAPD (r=0.423, P=0.02) and the extent of RD (r=0.417, P=0.011) significantly affected visual outcomes. Preoperative macular status (attached vs detached) also had a significant effect on the visual outcomes (P<0.001). However, multivariate analysis revealed that only macular status (P=0.022) was significantly associated with final vision. Age, duration of symptoms (less vs more than 7 days), preoperative visual acuity, visibility of retinal breaks, number of breaks and cryotherapy spots, performing cryotherapy and SRFD, and lens status had no effect on final visual outcomes. No change in visual acuity was noted during the follow-up period.

Reoperations included 24 (21.4%) cases of pars plana deep vitrectomy, 4 (3.6%) cases of pneumatic retinopexy and 3 (2.7%) cases of buckle revision. The buckles were removed in 9 eyes which were silicone sponges placed radially or circumferentially each in 4 (3.6%) cases and an encircling band and silicone tire in one case (0.9%). Causes for buckle removal were: motility disturbance in 4 (3.6%) eyes, cosmetic concerns in 3 (2.7%) eyes, and extrusion in 2 (1.8%) cases. One of the encircling buckles was cut due to induction of high refractive error.

Table 2 Preoperative status according to buckling technique

	Radial (n=27)	Segmental Circumferential (n=16)	Encircling (n=68)	Total (n=111)	P value
Extent of RD (quadrant)*	2.5±0.96	2.4±0.84	2.8±0.94	2.7±0.95	0.109**
Macula-off	23/27	13/15	58/67	94/109	0.98†
Undetectable retinal break	0/27	1/15	17/51	18/93	0.006†
Number of breaks*	1.29±0.67	1.56±0.89	1.64±0.92	1.52±0.85	0.24**
Duration of RD (days)*	33.96±70.9	126.7 8±212.66	64.52±147.53	66.76±146.61	0.136**
Pre-op VA (logMAR)*	1.97±0.88	1.73±1.08	1.73±0.93	1.79±0.94	0.529**
Pre-op IOP (mmHg)*	11.22±4.16	13.4±5.91	10.91±3.71	11.37±4.27	0.130**
RAPD*	1.77±1.06	1.91±1.04	1.34±1.12	1.52±1.11	0.145**
Aphakia or pseudophakia	2/27	1/16	18/68	21/111	P=0.032†

RD, retinal detachment; VA, visual acuity; IOP, intraocular pressure; RAPD, relative afferent pupillary defect.
*mean±standard deviation, **ANOVA test, †Chi-square test. Note: only valid numbers and percentages are presented.

Table 3 Cryotherapy and subretinal fluid drainage in different buckling procedures

	Radial (n=27)	Segmental Circumferential (n=16)	Encircling (n=68)	Total (n=111)	P value
Cryotherapy	25 (92.6%)	12 (75.0%)	42 (61.8%)	79 (71.2%)	0.011†
Number of cryospots*	2.7±1.96	3.63±2.01	2.87±2.17	2.93±2.08	0.463**
SRFD	6 (22.2%)	4 (25.0%)	24 (35.3%)	34 (30.6%)	0.40†

SRFD, subretinal fluid drainage. *mean±standard deviation, †Chi-square test, **ANOVA test.

Table 4 Outcomes of different buckling techniques

	Radial (n=27)	Segmental circumferential (n=16)	Encircling (n=68)	Total (n=111)	P value
Change in VA from baseline (logMAR)					
1 mo	-0.66±0.89	-0.80±1.21	-0.54±0.94	-0.60±0.96	0.677*
3 mo	-0.95±0.62	-0.88±1.30	-0.62±0.99	-0.75±0.97	0.4*
6 mo	-0.71±0.86	-0.60±1.59	-0.83±0.99	-0.75±1.08	0.82*
12 mo	-0.98±0.81	-0.47±1.18	-0.55±1.04	-0.66±1.01	0.42*
Complete reattachment					
3 mo	18/23 (78.2%)	12/14 (85.7%)	49/58 (84.5%)	79/95 (83.1%)	0.76†
6 mo	16/20 (80%)	12/15 (80.0%)	45/52 (86.5%)	73/87 (83.9%)	0.58†
12 mo	15/17 (88.2%)	13/13 (100%)	45/48 (93.75%)	73/78 (93.6%)	0.426†

*ANOVA, †Chi-square test.

DISCUSSION

Single operation anatomical success rates of up to 92.5% have been reported following scleral buckling. The best results to date have been described by Kreissig et al[10] with minimal scleral buckling surgery. The underlying principle in scleral buckling is compression of the globe wall to provide RPE opposition to the neurosensory retina thereby interfering with passage of liquid vitreous into the subretinal space. If the break is properly closed, the RPE pump actively absorbs subretinal fluid and the retina will spontaneously reattach with no need for SRFD.[9,10,12] It is desirable to avoid SRFD and its associated complications such as subretinal hemorrhage, and vitreous or retinal incarceration into the site of drainage whenever possible.[1,9] In certain circumstances advantages of drainage seem to outweigh its disadvantages, such as eyes in which the break remains open despite proper buckle position. Although we found no significant effect from SRFD on reattachment rates, the non-randomized nature of our study precludes drawing definite conclusions in this regard. It is possible that more

complicated cases underwent SRFD which could have failed due to the nature of the detachment.

During the first decades following the development of scleral buckling, cryotherapy of the retinal breaks was performed in all cases to produce chorioretinal adhesions and prevent passage of fluid through the break. Nevertheless, it has been known that cryotherapy can enhance proliferative vitreoretinopathy,[1] therefore it can be avoided in eyes in which the break lies flat over the buckle.[7,8] Postoperative laser treatment is a good alternative in these cases.[1,13] In the current study, we found no significant effect from cryotherapy on anatomical success rates. Our findings regarding the effect of cryotherapy and SRFD on anatomical and visual outcomes of scleral buckling are consistent with those of Salicone et al[14] who reported no significant effect from intraocular gas injection, subretinal fluid drainage and lens status on anatomical and visual outcomes of scleral buckling for RRD. Again due to the non-randomized nature of the study, one cannot draw generalizable conclusions in this matter.

Pseudophakic RRD has been associated with poorer prognosis as compared to phakic detachments.[15] This has been attributed to lower preoperative visual acuity, higher incidence of total and macula-off RDs, and less frequent identification of retinal breaks. Twenty-one eyes in the current series were aphakic or pseudophakic, however these eyes did not differ from their phakic counterparts in terms of anatomical and visual outcomes. In the PARD study,[16] pseudophakic/aphakic eyes were randomized to scleral buckling or primary vitrectomy but no significant difference was found in the anatomical success rates after 6 months.

The only significant factor influencing retinal reattachment rate was the number of retinal breaks. Presence of multiple retinal breaks not only adds to the complexity of operation but also is a risk factor for development of PVR.[17] Afrashi et[18] al also found the only factor predictive of anatomic failure to be preoperative PVR more than grade C1 and multiple retinal breaks.

Chronicity of RD has been reported as a poor prognostic indicator for reattachment surgery.[19] However, in the current study we found no correlation between duration of RD and anatomical success rates. The duration of RD was more than 1 month in 20% and more than 3 months in 14% of eyes in our series. The lack of any influence from the duration of RD might be due to bias introduced by selection of old RDs without PVR for scleral buckling. Retinal shortening and high viscosity subretinal fluid due to chronic RD are factors which seem to hinder retinal reattachment in these eyes. Surprisingly, in chronic cases in which the break was adequately closed by the buckle, subretinal fluid resorbed promptly, often within the first 72 hours. We therefore believe that SRFD is not mandatory in chronic RDs, provided that the break is adequately sealed. When there is no PVR and the break is adequately supported, there seems to be no adverse effect on reattachment from chronicity of the RD per se.

Macular detachment results in poor visual outcomes following scleral buckling such that macula-off RD is associated with much worse visual prognosis.[20] Macular detachment also has been found to adversely affect anatomic outcomes of surgery.[14] Although macular detachment did not affect anatomical success rates in our series, it was a significant prognostic factor for visual outcomes at 6 months. A similar trend was observed for the extent of RD such that it had no effect on reattachment rates but was correlated with visual results at six months. The effect of the extent of RD on visual outcomes was not confirmed as an independent factor in multivariate analysis. The apparent impact of the extent of RD on visual outcomes may be a parallel effect of macular detachment because more extensive RDs are more likely to involve the macula. We did not find any correlation between duration of RD and postoperative vision, and visual outcomes were comparable in eyes with duration of symptoms less and more than 7 days. This finding is consistent with the report by Salicone et al.[14] Improvement in visual acuity after scleral buckling is possible over a long period[21] but we were unable to show this trend in our study.

Conventional scleral buckling appears as a safe and effective surgical technique for pri-

mary management of uncomplicated RRDs with unseen retinal breaks when the media is clear.[22] Some studies have found lower primary success rates in eyes without visible retinal breaks.[23] We could not detect the retinal break in 17.7% of our patients which is comparable to the report by Kocaoglane et al.[23] However, unseen retinal breaks did not influence anatomical outcomes in our patients. It seems that using Lincoff's rules for predicting the site of retinal breaks and placement of the buckle has been successful in these eyes although surgery was somewhat more extensive than eyes with visible breaks.

Encircling scleral buckling procedures have been associated with impaired chorioretinal blood flow and even visual field defects.[12,24-27] Limited scleral buckling techniques avoid this and involve less manipulation of orbital tissues resulting in their widespread adoption in recent years. One drawback to segmental buckles is the increase in higher order aberrations (HOAs) to a greater extent and for a longer duration than encircling buckles which may be the cause of visual disturbances after segmental buckling procedures.[28] In our series, 38.7% of buckling procedures were segmental but there was no difference between eyes undergoing segmental (radial or circumferential) buckling and those with encircling procedures in terms of visual outcomes.

One drawback to segmental buckling using silicone sponges in the current series was the high rate of buckle removal. All buckles which were removed for cosmetic reasons were placed circumferentially, but of those removed for motility disturbances, 3 were radial and one was circumferential. Intrusion and extrusion of scleral buckles may occur following scleral buckling.[29,30] We did not encounter any intrusions and only 2 cases of extrusion were recorded. In the study by Ho et al[31], visual and anatomic results, and complication rates did not differ among the three buckling techniques but in the current study, we were obliged to remove more sponges than silicone tires both for cosmetic and motility reasons.

Our single operation anatomical success rate of 89.3% at six months and comparable anatomical and visual outcomes with different buckling techniques is in line with other studies.[18,31] Therefore, although limited buckling techniques are more attractive because of less manipulation of orbital tissues and shorter operation time, the visual and anatomical results are not different from the more extensive encircling technique. There may be more need for removal of the buckle in the limited buckling techniques.

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