European Journal of Ophthalmology / Vol. 16 no. 4, 2006 / pp. 536-541

Corneal topographic changes after scleral buckling

F. KARIMIAN[1], S. MORADIAN[2], S. YAZDANI[3], A. MASHAYEKHY[2], A. ANISIAN[4], N. KOUHESTANI[4]

Department of Ophthalmology, Labbafinejad Medical Center (LMC), Shaheed Beheshti University of Medical Sciences, Tehran - Iran

PURPOSE. *To evaluate corneal topographic changes and induced corneal astigmatism after scleral buckling (SB).*

METHODS. *This interventional case series includes all patients who had undergone scleral buckling for rhegmatogenous retinal detachment (RRD) during a 1-year period. Patients were divided into four groups according to type and extent of scleral buckling which depended on the discretion of a retina specialist. Videokeratography was performed for all patients preoperatively and repeated 1 and 3 months after SB.*

RESULTS. *Thirty-nine eyes of 39 patients (29 male, 74.7%) with mean age of 50.35±20 years (range 13–80) were finally analyzed. There was no statistically significant difference among the groups in terms of preoperative corneal astigmatism, surface regularity index (SRI), surface asymmetry index (SAI), mean keratometry (mean K), and potential visual acuity (PVA). Overall, preoperative mean K was 43.97±1.78 D, which reached 44.2±2.02 D and 43.92±2.16 D 1 and 3 months after the operation. Mean preoperative SRI was 0.58±0.4, which increased to 1.24±1.18 and 1.29±1.13 1 and 3 months after the operation respectively. Mean preoperative SAI was 0.39±0.21, which increased to 0.73±0.37 and 0.75±0.66 1 and 3 months after the procedure. Changes in SAI at 1 and 3 months following SB were significant (p values < 0.001); however, these postoperative values were not significantly different. Mean preoperative PVA was 0.07±0.75 logMAR (equivalent to 20/20) but decreased to 0.24±0.25 (equivalent to 20/30) and 0.27±0.29 (equivalent to 20/40) 1 and 3 months after SB, respectively.*

CONCLUSIONS. *Significant changes in corneal topographic indices including increases in SRI and SAI and a concomitant decrease in PVA may occur after SB procedures. These induced changes must be considered and appropriately addressed postoperatively to provide the best possible corrected vision. (Eur J Ophthalmol 2006; 16: 536-41)*

KEY WORDS. *Scleral buckling, Corneal topography, Mean keratometry, Surface regularity index, Surface asymmetry index*

Accepted: February 5, 2006

INTRODUCTION

Retinal detachment (RD), with a yearly incidence of 1 per 10,000 persons (1), is a potentially blinding ocular disorder if left untreated (2). With the recently improved rates of anatomic success with scleral buckling (SB) procedures, more attention has been paid to improve postoperative quality of vision (3).

It has already been shown that SB results in corneal deformation and induction of astigmatism. There are many reports of high astigmatism following scleral buckling leading to decreased visual acuity and metamorphopsia. This astigmatism may not be tolerable for the patient even with spectacle correction.

Some authors believe the induced astigmatism is mild, transient, and of no clinical significance; however, it may be

1120-6721/536-06$15.00/0

asymmetric, irregular, and result in visual deterioration (4, 5).

Most previous studies were based on the results of refraction and keratometry; however, since the Javal-type keratometer evaluates only the central 3 mm zone, it may not reflect changes in the whole corneal surface. In a study of corneal topographic changes after SB, it was shown that surface asymmetry index (SAI) and surface regularity index (SRI) are increased initially after SB but gradually decrease thereafter. Best-corrected visual acuity improved with decrease in SRI. These changes did not regress to baseline values 6 months postoperatively and the corneal surface remained irregular and asymmetric (6).

This prospective study was conducted to evaluate corneal topographic changes in subsets of patients undergoing surgery with different scleral buckling techniques.

MATERIAL AND METHODS

This interventional case series includes all patients who underwent scleral buckling for rhegmatogenous RD (RRD) at Labbafinejad Medical Center from January 2003 to February 2004. Patients with history of previous SB, any ocular surgery during the past 6 months, and any corneal disorder affecting videokeratography were excluded.

Patients were divided into four groups according to required type and extent of SB which depended on the discretion of a retina specialist (S.M., A.M.) based on size, number, and location of breaks, signs of PVR, aphakia or pseudophakia, presence of high myopia, and extent of lattice degeneration. Group A underwent 360° encircling buckle and band, Group B received a segmental buckle and an encircling band, meridional buckling was performed for Group C, and Group D underwent segmental circumferential buckling.

Videokeratography (Tomey, Topographic Modulating system, TMS-1 Computed Anatomy, New York) was performed by a skilled technician for patients preoperatively and repeated 1and 3 months after SB. Maps were prepared in normalized scale and interpreted by an independent observer (F.K). The following corneal indices were evaluated on each map: simulated keratometry (Sim k), mean keratometry (mean K), SRI, SAI, potential visual acuity (PVA).

Corresponding corneal indices Sim k, mean K, SRI, SAI, PVA) were evaluated in each session and PVA was changed into logMAR for better comparison with other examination sessions and then statistical analyses were performed and p values less than 0.05 were considered significant.

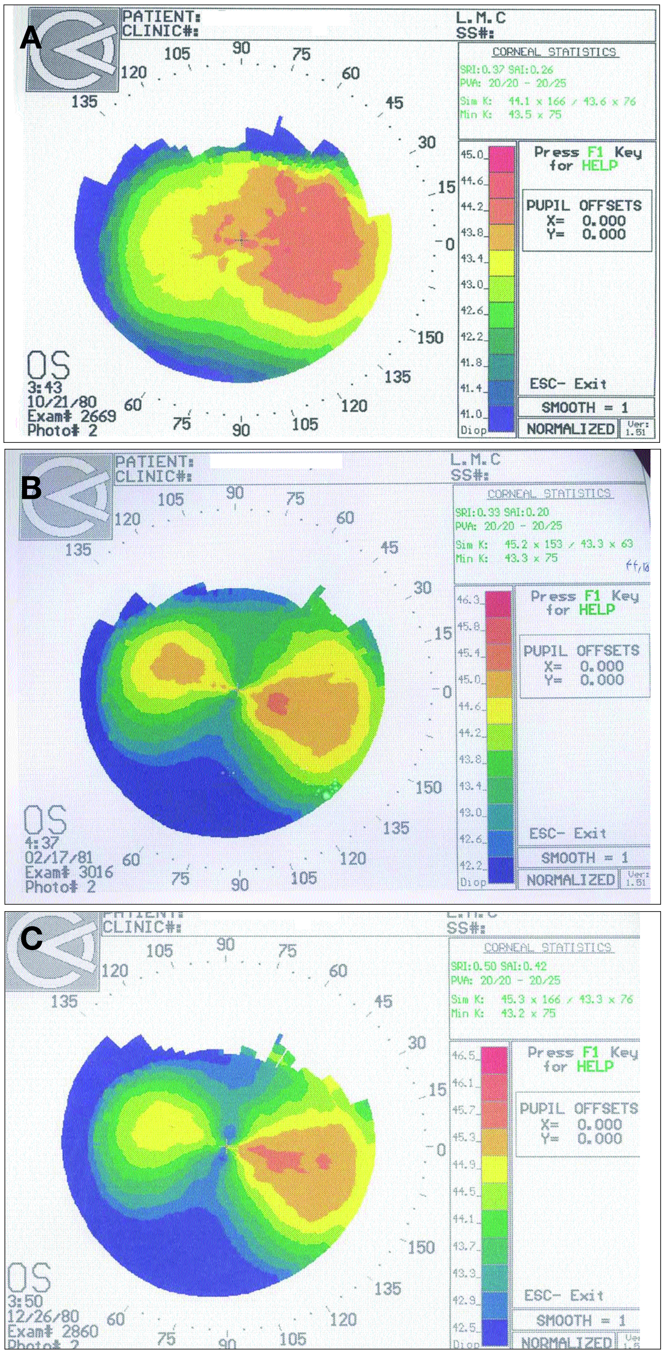

Fig. 1 - *Corneal topographic images before* (**A**) *and 1 month* (**B**) *and 3 months* (**C**) *after scleral buckling in a typical patient in Group A.*

RESULTS

During the mentioned period, 50 eyes of 48 patients were initially enrolled. A total of 11 eyes were excluded from final analysis due to altered surgical plan in five eyes, retinal redetachment within the first postoperative months

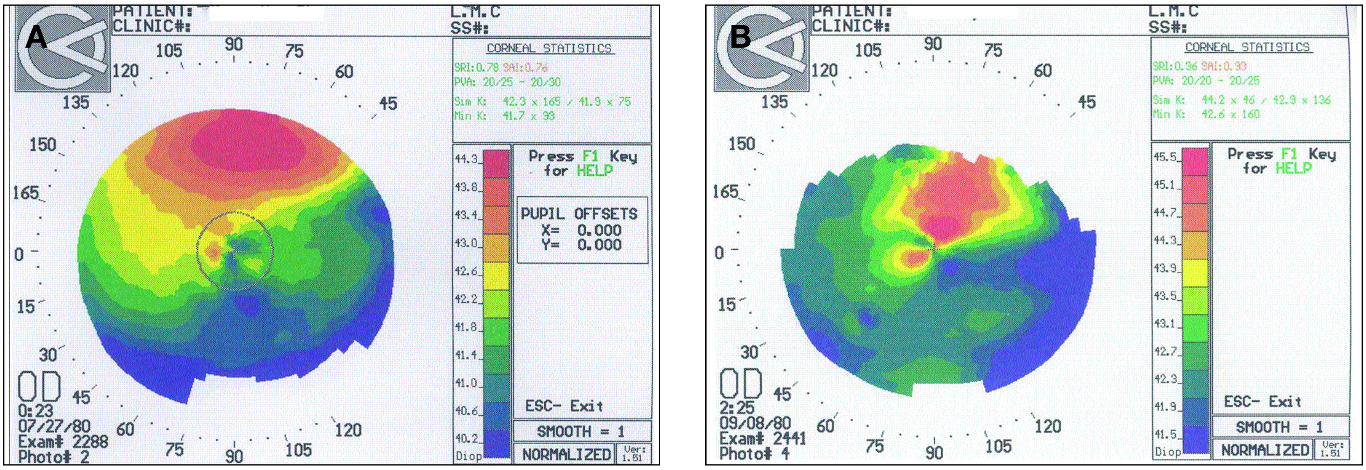

Fig. 2 - *Corneal topography maps in a typical patient in Group B before* (**A**) *and 3 months after scleral buckling* (**B**).

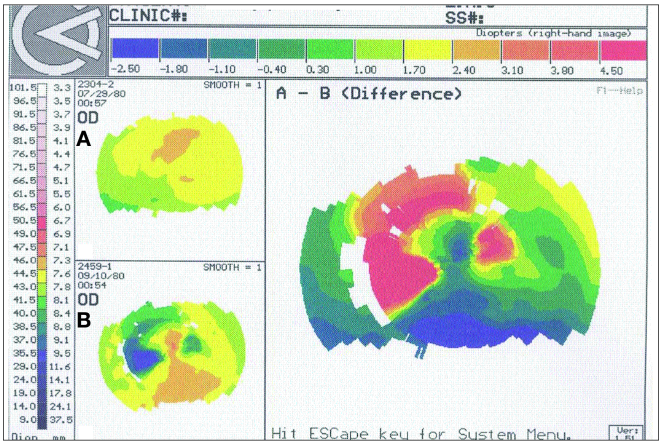

Fig. 3 - *Difference map topography of before* (**A**) *and 1 month after scleral buckling* (**B**) *in a patient in Group C.*

in two eyes, incomplete follow-up in three eyes, and death of one patient in one eye. Eventually 39 eyes of 39 patients with complete follow-up were allocated in four groups on the basis of the type of the required operation.

There were 29 male (74.4%) and 10 female (25.6%) subjects with mean age of 50.35±20 years (range 13–80 years). There were 3 eyes in Group A (Fig. 1), 30 eyes in Group B (Fig. 2), 4 eyes in Group C (Fig. 3), and 2 eyes in Group D (Fig. 4). Statistical analysis was not performed in Groups A, C, and D because of the low number of cases and only mean and standard deviation of corneal topographic indices were determined in Group B. There was no statistically significant difference among groups preoperatively, in terms of cylinder, SRI, SAI, mean K, and PVA (in logMAR).

Overall, mean preoperative keratometry (mean K) was 43.97±1.78 D, which reached 44.2±2.02 D and 43.92±2.16 D 1 and 3 months after the operation. No statistically significant differences were observed between any of these values (Tab. I).

Overall, mean preoperative SRI was 0.58±0.4, which increased to 1.24±1.18 and 1.29±1.13 1 and 3 months after the operation, respectively. There were statistically significant differences between the preoperative and 1 month postoperative SRI and also between the preoperative and 3 months postoperative SRI (p values, 0.004 and 0.003, respectively) but there was no significant difference between the 1 and 3 months postoperative values (Tab. II).

Overall mean preoperative SAI was 0.39±0.21, which increased to 0.73±0.37 and 0.75±0.66 1 and 3 months after the procedure. Changes in SAI 1 and 3 months following SB were significant (p values<0.001); however, the difference between these postoperative values was not significant (Tab. III).

Mean preoperative PVA (logMAR) was 0.07±0.75 (equivalent to 20/20) but decreased to 0.24±0.25 (equivalent to 20/30) and 0.27±0.29 (equivalent to 20/40) 1 and 3 months after SB, respectively. The differences between preoperative PVA and both postoperative values were significant (p value = 0.001) but no significant difference was present between the postoperative PVAs (Tab. IV).

Preoperative topographic patterns included the following: geographic (4 eyes), irregular (2 eyes), oval (5 eyes), asymmetric bowtie (12 eye), symmetric bowtie (9 eyes), round (4 eyes), and nonspecific (3 eyes). The topographic pattern did not change significantly postoperatively in 8 eyes. However, the following changes were observed as follows: symmetric to asymmetric bowtie (5 eyes), asymmetric to symmetric bowtie (3 eyes), oval to symmetric

TABLE I - COMPARISON OF MEAN K IN DIFFERENT SUBGROUPS

Mean K group	Preoperative mean ± SD	Postoperative mean ± SD 1 mo	3 mo
All patients	43.97 ± 1.78	44.20 ± 2.02	43.92± 2.16
Group A	43.88 ± 0.94	44.11 ± 0.24	44.46 ± 0.50
Group B	44.07 ± 1.74	44.28 ± 2.06	44.00 ± 1.76
Group C	43.26 ± 3.02	43.66 ± 3.13	43.06 ± 4.56
Group D	44.26 ± 0.38	44.8 ± 0.05	44.6 ± 0.35

Mean K = Mean keratometry

TABLE II - COMPARISON OF SRI IN PATIENT SUBGROUPS

SRI group	Preoperative mean ± SD	Postoperative mean ± SD 1 mo	3 mo
All patients	0.58 ± 0.40	1.24 ± 1.18*	1.29 ± 1.13*
Group A	0.62 ± 0.32	0.86 ± 0.24	0.72 ± 0.13
Group B	0.53 ± 0.40	1.28 ± 1.27*	1.21 ± 1.20*
Group C	0.86 ± 0.50	1.36 ± 1.19	2.16 ± 2.17
Group D	0.42 ± 0.74	0.37 ± 0.0	0.69 ± 0.04

p Values in comparison with preoperative measurement. *Paired t test $p<0.05$. SRI = Surface Regularity Index

TABLE III - COMPARISON OF SAI IN PATIENT SUBGROUPS

SAI group	Preoperative mean ± SD	Postoperative mean ± SD 1 mo	3 mo
All patients	0.39 ± 0.21	0.73 ± 0.37*	0.75 ± 0.66*
Group A	0.32 ± 0.08	0.90 ± 0.10	0.68 ± 0.34
Group B	0.38 ± 0.22	0.72 ± 0.36*	0.81 ± 0.73*
Group C	0.51 ± 0.52	0.69 ± 0.66	0.50 ± 0.34
Group D	0.37 ± 0.06	0.37 ± 0.0	0.48 ± 0.09

p Values in comparison with preoperative measurement; *Paired t test $p<0.05$; = SAI Surface Asymmetry Index

TABLE IV - COMPARISON OF CORNEAL PVA IN PATIENT SUBGROUPS

PVA group	Preoperative mean ± SD	Postoperative mean ± SD 1 mo	3 mo
All patients	0.07 ± 0.75	0.24 ± 0.25*	0.27 ± 0.29*
Group A	0.08 ± 0.05	0.13 ± 0.10	0.15 ± 0.00
Group B	0.05 ± 0.06	0.25 ± 0.27*	0.26 ± 0.26*
Group C	0.15 ± 0.10	0.28 ± 0.27	0.43 ± 0.44
Group D	0.02 ± 0.03	0.05 ± 0.00	0.12 ± 0.07

p Values in comparison with preoperative measurement.; *Paired t test $p<0.05$; PVA = potential visual acuity (PVA) in logMAR

bowtie (4 eyes), and oval to round (one eye). Nonspecific changes were observed in the remaining 18 eyes.

In Group B, out of 14 eyes with buckle extension of 0 to 90 degrees, steepening in the buckle area in seven eyes and flattening was observed in one eye.

In 12 eyes with buckle extension of 90–180 degrees, steepening (3 eyes) and flattening (1 eye) occurred in the buckle area.

DISCUSSION

The ophthalmologist is often confronted by less than expected visual acuity despite apparent anatomic success following scleral buckling procedures. Apart from the possibility of photoreceptor degeneration secondary to chronicity of RD, another possible explanation could be irregular astigmatism induced by the procedure.

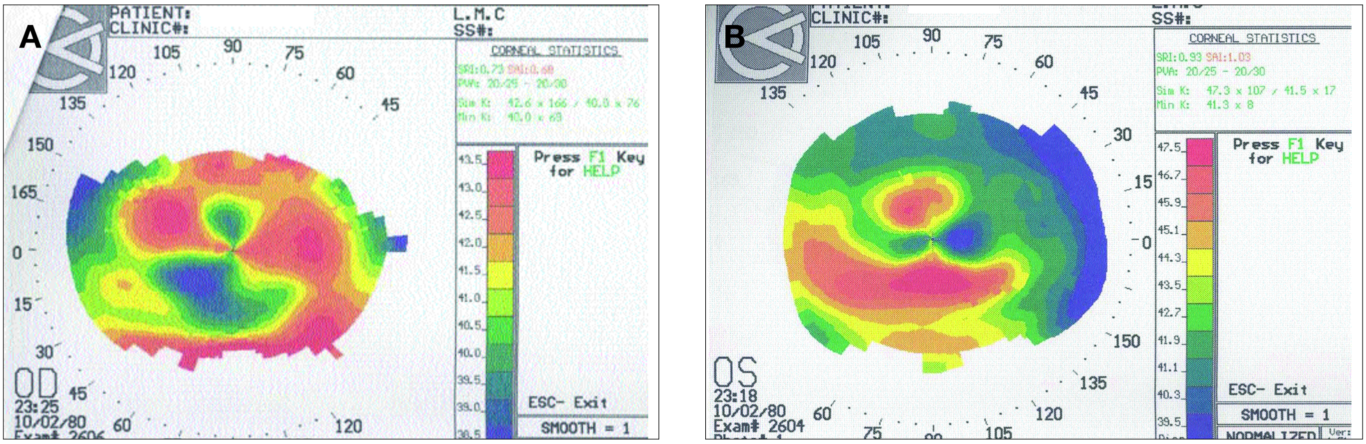

Fig. 4 - *Corneal topography maps of a patient in Group D comparing before* (**A**) *to 3 months after operation* (**B**).

There have been many studies reporting changes in corneal curvature and induction of postoperative astigmatism following scleral buckling (6). Since the invention of corneal topography and refinement in its software, the results of corneal topographic studies following scleral buckling have not been consistent. Some studies have shown the astigmatism following SB to be transient and clinically insignificant (6, 7); however, others have noted persistent changes for 6 months or more. This induced astigmatism may be irregular, asymmetric, and not correctable with spectacles, leading to a decrease in best-corrected visual acuity (6).

In the current study, changes in corneal astigmatism, SRI, SAI, mean keratometry, and PVA were evaluated after scleral buckling stratified according to the type of buckling. Meanwhile the effect of surgery on corneal topography pattern was studied. The methodology, patients, topography software, and the evaluated variables were similar to previous studies.

The SRI and SAI, which are criteria for corneal surface symmetry and regularity of the TMS-1 topographic software, have been used for evaluation and follow-up of changes after scleral buckling in some studies. In the Hayashi study, the amount of SRI and SAI increased after SB and did not regress up to 6 months after the operation (6, 8). On the other hand, in the Dominz et al study, these variables had a significant rise for 1 week after the operation and decreased afterwards (9). In the Tomidokoro et al study, astigmatism irregularity was increased significantly during the first week after the operation, but decreased afterwards and finally had no significant difference from preoperative values (3).

In our study, the amount of astigmatism increased after surgery and did not regress to the preoperative level after 3 months. SRI and SAI were also increased in all patients reflecting corneal surface irregularity. Changes in SRI and SAI after scleral buckling represent alterations of the corneal surface and therefore changes in overall refractive astigmatism, which may decrease potential visual acuity to variable degrees; the irregular nature of these alterations makes spectacle correction difficult. Increased SRI and SAI values are probably due to discrepant rates of buckle pressure over the sclera. Variable distances of the buckle to the limbus may have a non-uniform effect on the cornea, resulting in reduced corneal regularity and sphericity.

Conventional keratometry is of limited value in the evaluation of corneal surface changes after scleral buckling. In the Tomidokoro et al study, mean keratometry showed significant increase during the first week after SB but regressed to insignificant values at the end of the first month (3). Similar results were observed in our patients 1 month after surgery. However, in both studies corneal topography documented significant corneal changes after surgery, while mean keratometry among various groups and at different follow-up intervals showed no significant change. Stability of keratometric changes is probably due to barrier effect of limbus on corneal curvature: scleral indentation secondary to buckle effect causes corneal steepening in a certain meridian; however, due to the coupling effect of cornea, compensatory flattening of another meridian results in a stable mean keratometry.

PVA has been discussed only in the Dominz et al study, which reported a significant decrease within the first week with gradual improvement 1 to 3 months following surgery (9).

Similarly, in the current study mean PVA showed a significant decrease in all patients in various SB groups and did not return to preoperative levels up to 3 months following surgery. Since estimation of corneal potential visual acuity is based on SAI and SRI, the resulting decrease in PVA secondary to alterations in these indices is not unexpected.

Categorization of the extent of scleral buckling similar to our study was not performed in previous reports. Considering the overall topographic pattern, steepening in the buckle area was observed in 30% of patients in Group B (segmental circumferential buckle with encircling band); the corresponding figure in the Hayashi et al study was 61%. This difference in corneal steepening could be due to difference in suturing technique and tension. In our study among this subgroup of patients (Group B) increased steepening in the area of buckle was observed in 50% and 25% of eyes with buckle extension of 90 and 90–180 degrees, respectively. These findings showed that the chance of corneal steepening decreases with increasing extension of buckle over globe circumference. This inverse relation is probably due to propagation of forces over more extensive area, resulting in less steepening.

Previous studies have not evaluated the possibility of predicting corneal topographic changes after scleral buckling. In the current study no correlation was found between the overall topographic patterns before and after SB. This means that one may not be able to predict corneal changes or the overall topographic pattern after surgery according to preoperative pattern and the extent of the buckle.

CONCLUSIONS

Significant changes in corneal topographic indices including increases in SRI and SAI and a concomitant decrease in PVA may occur after SB procedures. Induction of irregular astigmatism may significantly affect performance. With the refinements in scleral buckling methods and increased rates of anatomic success, induced corneal topographic changes must be considered and appropriately addressed postoperatively to provide the best possible corrected vision.

None of the authors has a financial or proprietary interest in any mentioned product or material.

Reprint requests to:
Farid Karimian, MD
Department of Ophthalmology & Ophthalmic Research Center
Labbafinejad Medical Center
Boostan 9th St.
Pasdaran Ave.
Tehran, Iran 16666
karimianf@yahoo.com

REFERENCES

1. Heimann M, Burton T, Brown C. Epidemiology of retinal detachment. Arch Ophthalmol 1982; 100: 289-92.
2. Wilkinson MR, Rice T. Retinal Detachment. St. Louis: Mosby-Year Book; 1990: 243-300.
3. Tomidokoro A, Oshika T, Kojima T. Corneal astigmatism after scleral buckling surgery assessed by Fourier analysis of videokeratography data. Cornea 1998; 17: 517-21.
4. Burton TC. Irregular astigmatism following episcleral buckling procedure with the use of silicone rubber sponges. Arch Ophthalmol 1973; 90: 447-8.
5. Guell R, Crewdson J, Chignell AH. Astigmatism following retinal detachment surgery. Br J Ophthalmol 1983; 67: 327-9.
6. Hayashi H, Hayashi K, Nakao F, Hayashi F. Corneal shape changes after scleral buckling surgery. Ophthalmology 1997; 104: 831-7.
7. Fiore JV, Newton JC. Anterior segment changes following the scleral buckling procedure. Arch Ophthalmol 1970; 84: 284-7.
8. Ornek K, Yalcindag FN, Kanpolat A, Gunlap I. Corneal topographic change after retinal detachment surgery. Cornea 2002; 21: 803-6.
9. Dominz YY, Cahana M, Avini I. Corneal surface changes after pars plana vitrectomy and scleral buckling surgery. J Cataract Refract Surg 2001; 27: 868-72.