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Changes in axial length after retinal detachment surgery

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ABSTRACT: Purpose. *To evaluate changes in axial length and corneal curvature after an encircling procedure combined with segmental buckling.*

Materials and Methods. *We prospectively analysed cases with rhegmatogenous retinal detachment treated with an encircling band and scleral buckling surgery, comparing the pre- and postoperative ultrasonographic measurements of axial length and corneal curvature, and patients' age and sex in relation to the axial length of the eyeballs. We studied 74 patients (25 female, 49 male, aged 14-78 years, mean 46.7 years), who underwent retinal detachment surgery in 1995 and 1996.*

Results. *Axial eye length was significantly increased by surgery (median 0.77 mm one month after surgery). One year after treatment the elongation of the eye had decreased by 0.20 mm. The average increase of corneal curvature was 0.22 D one month after surgery, and 0.43 D at one year. The distribution of axial length showed a significant preponderance of eyes with a longer axial length among males.*

Conclusions. *Encircling with a scleral buckling procedure with moderate indentation causes axial elongation of the eye. (Eur J Ophthalmol 1999; 9: 115-9)*

KEY WORDS: Axial length, Retinal detachment, Encircling procedure, Buckling surgery

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INTRODUCTION

Ultrasonographic measurements have shown that the encircling procedure for retinal detachment alters the shape of the eyeball, changing the axial length. Shortening as well as elongation have been reported (1-7). A scleral buckle causes an indentation and a reduction in the radius of the eyeball. It may also cause axial lengthening or shortening, depending on the amount of indentation, whereas scleral resection usually results in axial length shortening (1, 3-6). The disparity in the results of different studies is possibly due to differences in surgical technique.

Surgical manipulations of the sclera, altering the shape of the eyeball, change refractive error. The nature of the change also depends on the type of operation. High equatorial indentation by buckles will shorten axial length causing a hyperopic shift in refractive error, while a low buckle may have the opposite effect (8-10). Scleral buckling procedures employing an encircling band generally increase myopia (1, 4-6, 10). However, the postoperative shift in refractive error may be caused not only by a change in eye length, but also by an alteration in corneal curvature (6, 7, 9, 11). Unfortunately there are only few prospective studies on the shape of eyes with retinal detachment, comprising a small number of cases and concerning either encircling scleral buckles or segmental buckles.

The purpose of our study was to evaluate changes in axial dimensions and corneal curvature after an en-

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circling procedure combined with application of a scleral buckle, and to examine the relation between eye length and patient's age and sex.

MATERIALS AND METHODS

We prospectively analysed axial length changes of the eyeballs of patients who had undergone retinal detachment surgery in our facility in 1995 and 1996. Included were patients with nontraumatic, rhegmatogenous retinal detachment with peripheral or equatorial retinal breaks. Excluded were patients who had a history of eye surgery, retinal disease, inflammatory ocular disease, macular hole and retinal breaks in the posterior pole and in whom the retinal break could not be identified. The caselist comprised 74 patients (25 female, 49 male) aged from 14 ot 78 years (mean 46.7 years).

All eyes were treated with an encircling silicone rubber band, 2 mm wide, with silicone rubber explants (spanning one quadrant parallel to the limbus) under the band in order to create the local buckling. No silicone sponges were used. In all cases cryopexy and drainage of subretinal fluid were done. The band was tightened as necessary to induce a moderate equatorial indentation, under control with the indirect ophthalmoscope, making sure that the central retinal artery remained patent.

Axial measurements were obtained with an A-scan instrument (Teknar). Cycloplegic drugs were administered before all measurements. An average of five measurements were analyzed for each patient. The maximal deviation from the mean axial length based on these five measurements was 0.13 mm. Any values larger than this were considered real. Axial length was measured preoperatively and one month and one year after surgery.

The corneal radius of curvature was determined preoperatively with the videokeratograph (Eyesys) in the main meridians and repeated one month and one year postoperatively. Corneal curvature was determined as the average of maximal and minimal curvatures.

Statistical analysis

Normally distributed data are expressed as mean and standard deviation. Parameters with a non-Gaussian distribution are presented as median, with interquartile range. In such cases the Mann-Whitney U-test was used for ordinal data and independent samples, the χ^2 test for independent samples and nominal data, the Wilcoxon matched sign rank test for ordinal data and dependent samples, and the Spearman rank correlation coefficient to determine the association for ordinal variables; A P-value below 0.05 was considered statistically significant.

TABLE I - AGE OF PATIENTS

Age (years)	No. of patients
<20	7
21-30	17
31-40	10
41-50	8
51-60	16
61-70	12
>70	4

TABLE II - SEX AND AXIAL LENGTH

Axial length (mm)	Men	Women	Male/female ratio
<23.0	6	4	1.5
23.1 - 24.0	7	7	1.0
24.1 - 25.0	7	2	3.5
25.1 - 26.0	8	5	1.6
26.1 - 27.0	9	3	3
27.1 - 28.0	6	2	3
28.1 - 29.0	6	2	3

RESULTS

Of the 74 patients, 62% were over 30 years old (Tab. I). Median axial length before surgery in our material was 25.21 mm (interquartile range 3.01). Median axial length in the women was 23.59 mm (interquartile range 3.34), and 25. 09 mm in the men (interquartile range 3.42). There was a significant preponderence of eyes with longer axial length in males than females (Mann-Whitney test, $P < 0.01$) (Tab. II). The male/female ratio was 3 in eyes with axial length > 26.0 mm and that of the whole group was 2.4. Axial lengths were longer than 26.0 mm in 21 of the male eyes (42.8%), and in 7 eyes in females (28.0%). There was a sig-

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TABLE III - PRE- AND POSTOPERATIVE CORNEAL CURVATURE IN PATIENTS UNDERGOING AN ENCIRCLING PROCEDURE WITH SEGMENTAL BUCKLING

Major meridian power	Preoperative corneal curvature (D)		Postoperative corneal curvature (D) After 1 month		Postoperative corneal curvature (D) After 1 year	
	Mean	SD	Mean	SD	Mean	SD
Minimum	42.81	1.46	42.79	1.60	42.92	1.47
Maximum	43.54	1.49	44.00	1.64	44.29	1.57

TABLE IV - POSTOPERATIVE AXIAL LENGTH CHANGES IN PATIENTS UNDERGOING AN ENCIRCLING PROCEDURE WITH SEGMENTAL BUCKLING (significant elongation in all eyes, $P < 0.0001$)

Axial length (mm)	Before operation		One month after operation			One year after operation		
	Median	Inter quartile range	Median	Inter quartile range	Difference (Median)	Median	Inter quartile range	Difference (Median)
<23.0	22.50	0.51	23.32	0.34	0.76	23.12	0.12	0.55
23.1-24.0	23.46	0.41	24.19	0.19	0.78	23.96	0.21	0.48
24.1-25.0	24.31	0.22	25.09	0.23	0.70	24.89	0.27	0.45
25.1-26.0	25.29	0.34	26.09	0.21	0.74	25.94	0.17	0.58
26.1-27.0	26.42	0.32	27.05	0.21	0.73	26.98	0.21	0.56
27.1-28.0	27.39	0.38	28.18	0.31	0.84	28.02	0.20	0.68
>28.1	28.15	0.19	29.15	0.25	0.94	28.79	0.09	0.57

nificant correlation between axial length and sex (χ^2 test for the groups with axial length shorter or longer than 26.0 mm, $P < 0.05$).

Table III shows the preoperative and postoperative mean corneal curvature. Before surgery the mean corneal curvature was 43.18 D, one month after 43.40 D, and one year after 43.6 D. The mean increase in corneal curvature was 0.22 D one month after surgery, and 0.43 D at one year (Tab. III).

Table IV presents the postoperative changes in axial length after the encircling procedure with scleral buckle. This operation caused significant elongation in all eyes one month and one year after surgery (Wilcoxon test, $P < 0.0001$). The median elongation one month after surgery was 0.77 mm (median length 26.01 mm, interquartile range 2.89). The elongation decreased by 0.20 mm one year after surgery, and the median axial length one year postoperatively was 25.85 mm (interquartile range 3.0). There were no significant differences in postoperative axial elongation in relation with the preoperative values (Spearman rank correlation coefficient, $P < 0.0001$).

DISCUSSION

Patient characteristics and axial lengths in our series are in agreement with previous reports (9, 12). The findings confirmed some common features concerning relations between age and sex of patients with rhegmatogenous retinal detachment. We also noted a tendency for retinal detachment to occur in men. The male/female ratio in our series was 2.4. There was a significant preponderence of males with eyes longer than 26.0 mm.

The encircling procedure with segmental buckle induced axial elongation in all cases. The average elongation one month after surgery was 0.77 mm, and 0.57

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mm at one year. In Rubin's experimental studies encircling procedures with 2-mm silicone bands changed axial length depending on the tightening of the band (8). A moderate indentation of the band caused mean axial elongation of 1.09 mm, while high indentation caused elongation of 0.35 mm. Larsen et al concluded that an encircling procedure with moderate band indentation induced an average axial elongation of 0.98 mm (4).

Surgical manipulation of the sclera frequently causes changes in refractive error (6, 9, 10). The scleral buckle causes an indentation and a reduction in the radius of the eyeball, and high equatorial indentation by a buckle will shorten the axial length, causing a hyperopic shift in refractive error, while a low buckle may have the opposite effect (4-6, 8-10). Construction with an encircling buckle will cause a lengthening of the eyeball and a myopic shift in refractive error. According to Rubin, 1 mm of axial increase produces 2.564 D of myopic shift at the spectacle lens plane in the phakic eye (8). This is close to the mean refractive change of -2.4 D (0.98 mm axial elongation after an elongation procedure) found by Larsen (4).

Our results show that the mean postoperative change of axial length one month after surgery could induce a refractive change of approximately 2.0 D (0.77 mm axial elongation) to myopia, and at one year the myopic shift was approximately 0.55 D (0.57 mm axial elongation). However, the refractive power of any eye depends both on its axial length and on the refractive power of the ocular components. The postoperative shift in refractive error may be caused not only by a change in eye length, but also by an alteration in corneal curvature. We found that the encircling procedure with segmental buckling caused an average postoperative increase of corneal curvature of 0.22 D one month after surgery and 0.43 D at one year.

Tanihara (9) showed that a myopic change in refractive error status after scleral buckling was due primarily to the change in eye length, and that an encircling buckle caused a myopic shift in refractive status due to changes in both eye length and corneal curvature. Thus, the myopic shift in our study due to the change of corneal curvature after the encircling procedure combined with segmental buckling might be reduced by a hyperopic shift due to the shortening of the eye axis caused by segmental buckling.

The exact mechanisms by which retinal detachment surgery alters refractive status remain unknown. Components other than ocular shape alternations have been suggested such as shallowness of the anterior chamber, increased lens thickness, displacement of the lens, impaired accommodation. These components, however, appeared to be transient or possibly transient. Larsen, unlike some other authors, did not find any change in the anterior segment dimensions (2, 4).

Our study suggests that after the scleral buckling procedure changes in the axial length and corneal curvature are to be expected and are important factors in the refractive status after retinal detachment surgery. These data regarding the shape of eyes after retinal detachment surgery should be considered when planning such treatment, as well as during postoperative care in view of the possible surgically induced changes in the refractive status of these eyes.

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