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Short-term effects of horizontal muscle operations on anterior and posterior segment parameters in strabismus patients

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ABSTRACT

Aim: To evaluate the short-term effects of horizontal muscle resection (Rt) or recession (Rs) surgeries on anterior and posterior segment parameters (ASPs and PSPs) in strabismus patients, using Pentacam HR and optical coherence tomography (OCT) devices.

Material and Method: This prospective study included 21 female and 17 male patients who underwent horizontal muscle surgery (Rt or Rs). ASPs were evaluated with Pentacam HR and PSPs were evaluated with OCT, one day before and one month after surgery.

Results: The mean age of all the patients included in the study was 16.52±7.90 years. Rt surgery was performed on 18 patients and Rs surgery on 20 patients. When the pre- and postoperative measurement values of all patients were compared, statistically significant differences were found in respect of iridocorneal angle (ICA) 90° and anterior chamber depth (ACD) in both the Rt and Rs groups. A significant narrowing was detected in ICA 90° and ACD in Rt patients ($p<0.01$), and significant enlargement was detected in Rs patients ($p<0.01$).

Conclusion: While ACD and ICA 90° may be affected in the short term following Rt and Rs surgeries, no significant changes were seen in the other ASPs and PSPs.

Keywords: Anterior chamber depth, anterior segment parameters, iridocorneal angle, optical coherence tomography, Pentacam HR

INTRODUCTION

Strabismus surgery is currently a frequently applied intervention, especially in pediatric patients. It has been reported that changes occur in anterior and posterior segment parameters (ASPs and PSPs) after strabismus surgeries performed due to ocular or extraocular disorders (1-5). Previous studies have discussed the changes in the anterior segment, especially in the cornea, iris and lens, and it has been concluded that these changes are mostly temporary. (6-8) However, there are also publications reporting that they can be long-term (up to 1 year) or permanent (3, 9, 10). In studies on the posterior segment, changes in the parameters of central retinal thickness (RT), subfoveal choroidal thickness (CT), and retinal nerve fiber layer (RNFL) are predominant (1, 5).

Pentacam® HR (Oculus Inc, Berlin, Germany) is a high-resolution rotating Scheimpflug camera system for anterior segment analysis. It provides clear visualization of the cornea, iris and lens, and measures anteroposterior corneal topography and elevation, corneal refractive power, 360° iridocorneal angle (ICA), anterior chamber depth (ACD), the cornea, and lens optic opacities (11-13). Although it is used especially in the diagnosis and follow-up of corneal diseases, there has been a recent increase in its use in glaucoma, cataract, and strabismus diseases (14-16).

Spectralis optical coherence tomography (OCT) (Heidelberg Engineering, Heidelberg, Germany) is a device widely used in ophthalmology clinics to view posterior segment structures, particularly the retina and choroid. OCT has recently gained importance in the treatment and follow-up of strabismus patients, as it provides valuable information. Especially the changes in ASPs before and after strabismus surgery have started to be a matter of interest in research (1, 5).

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The effect of strabismus surgery on corneal topography and refraction has been extensively studied. However, the number of articles examining the effect on PSPs is limited. Moreover, to the best of our knowledge, there is no study in the literature that has evaluated the effect of strabismus surgery on ASPs and PSPs together. The aim of this study was to determine the effect on ASPs and PSPs of both resection (Rt) or recession (Rs) surgery applied to horizontal muscles through evaluations made using Pentacam HR and Spectralis OCT devices

MATERIAL AND METHOD

This study was conducted in the Ophthalmology Department of Bolu Abant İzzet Baysal University Faculty of Medicine. The study was carried out with the permission of Bolu Abant İzzet Baysal University Clinical Researches Ethics Committee (Date: 22.03.2022, Decision No: 131) and all procedures complied with the tenets of the Helsinki Declaration. Written informed consent was obtained from all patients and/or their parents.

This prospective study included a total of 38 patients, comprising 21 females and 17 males. One day before the operation and one month after the operation, the ASPs, and PSPs of the patients were evaluated with the Pentacam HR (**Figure**) and OCT devices. ACD, central corneal thickness (CCT), anterior and posterior radius of curvature (ARC and PRC), ICA 90° and 180° measurements were automatically calculated and presented as numerical values using Pentacam HR (Figure). The RT and RNFL measurement values were calculated automatically on the the OCT device. The CT measurements were taken manually.

Patients were excluded from the study if the data were insufficient or unreliable, if they did not attend follow-up appointments regularly (n:2), or if the quality of measurements taken with the Pentacam HR or OCT devices was <8/10 (n:3). Patients with secondary strabismus due to any pathological reason, those with eye pathologies other than strabismus, or a history of recent eye surgery were also excluded from the study.

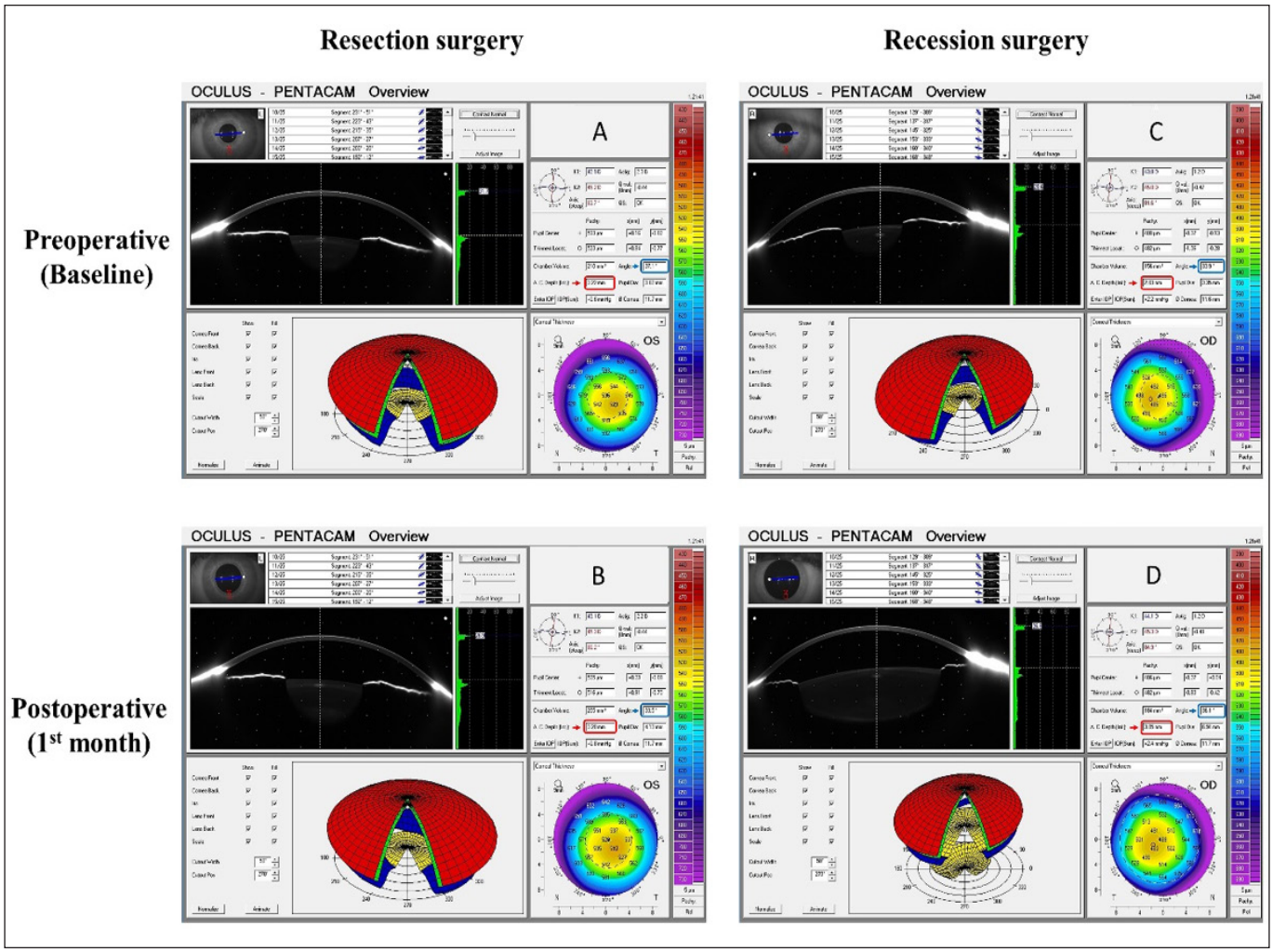

Figure 1. Pentacam HR measurements before and after strabismus surgery.
A-B: Preoperative and postoperative Pentacam HR measurements of a patient undergoing resection surgery. It is observed that there is a decrease in the postoperative ACD and ICA values (Colored arrows).
C-D: Preoperative and postoperative Pentacam HR measurements of another patient undergoing recession surgery. It is observed that there is an increase in the postoperative ACD and ICA values (Colored arrows).
ACD: Anterior Chamber Depth, ICA: Iridocorneal Angle.

Statistical Analysis

Data obtained in the study were analyzed statistically using SPSS for Windows, vn. 25.0, software. Results were stated as mean±standard deviation (SD) values. The parameters were evaluated with the Paired Samples t-test if they met the assumptions of normal distribution with the one sample Kolmogorov Smirnov test, and homogeneity with the Kaiser-Meyer-Olkin test and Bartlett's Test of Sphericity. If the study data did not meet the parametric test assumptions, statistical evaluation was made using the Wilcoxon signed-rank test. A value of $p<0.05$ was accepted as statistically significant.

RESULTS

The mean age of the patients included in the study was 16.52±7.90 years (range, 8-30 years). All the patients were diagnosed with esotropia or exotropia, and interventional surgery was applied to the lateral or medial rectus. Rt surgery was performed on 18 patients and Rs surgery on 20 patients. Postoperative complications were not observed in any of the patients. All the patients received routine topical antibiotics and steroid therapy for approximately 2 weeks postoperatively.

Preoperative and postoperative measurements were taken of the 38 patients who underwent strabismus surgery, and calculations were made to determine whether the difference between the measurements was statistically significant (**Table**). In both the Rt and Rs patients, the differences between the preoperative and postoperative values of CCT, ARC, and PRC were not statistically significant (p range: 0.34-0.71). No statistically significant difference was determined between the Rt and Rs surgery groups in respect of the preoperative and postoperative measurements of ICA 180° (p=0.42, and p=0.66, respectively). The ICA 90° value showed a statistically significant difference from preoperative to postoperative in both Rt and Rs patients ($p<0.01$ and p=0.04, respectively). Mean 3.52±6.84° enlargement was observed in the ICA 90° value in patients who underwent Rs surgery, and mean 5.35±4.76° narrowing was observed in the Rt surgery group. The mean ACD values decreased by 0.08±0.07 mm in the Rt surgery patients ($p<0.01$) and increased by 0.04 ± 0.07 mm in the Rs surgery group (p=0.04); these values were statistically significant in both groups. No statistically significant difference was found between the preoperative and postoperative values of RT, CT, and RNFL measurements made with the OCT device in both the Rt and Rs patient groups (p range: 0.14-0.67).

DISCUSSION

The results of this study demonstrated that while ICA 90° and ACD can be affected in the short term after Rt and Rs surgeries, no significant change was observed in the other ASPs and PSPs. This suggests that the changes in ACD and ICA 90° after strabismus surgeries may have resulted from the mechanical effects caused by changes in the attachment points of the horizontal muscles to the sclera and postoperative wound inflammation. Although the cause of ASP and PSP changes after strabismus surgery is unclear, some of these changes are part of the wound healing mechanism in the re-insertion of the extraocular muscle on the sclera (17). In addition, changing the positions of the extraocular muscle insertions can modify the vector forces exerted on the cornea, resulting in changes in corneal curvature and astigmatic refractive errors (10, 18).

Emre et al. (6) examined changes in ASP in a total of 18 patients who underwent Rs and Rt plus Rs using Pentacam and found that the anterior chamber volume decreased statistically significantly in the Rt plus Rs group. Similarly, Jung et al. (7) evaluated the ASPs of patients who underwent Rs and Rt plus Rs with Pentacam and found that ACD significantly decreased in the Rs group and recovered 3 months after surgery. In another study, it was reported that patients showed statistically significant changes in refractive error, anterior chamber volume and ACD one week after surgery (19). In the present study, while ICA 90° and ACD values decreased postoperatively in Rt patients, they were determined to

Table 1. Measurement values of pre-and postoperative anterior and posterior segment findings with Pentacam HR and OCT devices

	Resection (n: 18)			Recession (n: 20)		
	Preoperative	Postoperative	P*	Preoperative	Postoperative	P*
ICA 90°	39.01±8.08	33.66±5.74	<0.01	36.86±7.58	40.38±10.30	0.04
ICA180°	39.49±7.54	38.42±9.57	0.42	3882±837	39.49±6.87	0.66
ACD (mm)	3.29±0.38	3.21±0.36	<0.01	3.08±0.17	3.12±0.18	0.04
CCT (μm)	534.44±36.61	535.28±34.93	0.64	549.37±43.43	548.68±41.79	0.71
ARC (mm)	7.58±0.34	7.57±0.35	0.59	7.69±0.32	7.64±0.28	0.55
PRC (mm)	6.02±0.36	6.04±0.37	0.47	5.86±0.64	6.01±0.47	0.34
Retinal thickness (μm)	227.22±13.61	227.89±13.13	0.60	221.39±14.44	228.61±22.17	0.14
Choroidal thickness (μm)	344.67±51.96	330.78±43.96	0.25	339.11±69.47	335.06±83.89	0.67
RNFL (μm)	96.94±8.39	96.56±8.52	0.64	102.42±7.46	101.53±6.98	0.20

* $p<0.05$ indicates a statistical significance, ACD: Anterior chamber depth, ARC: Anterior radius of curvature, CCT: Central corneal thickness, ICA: Iridocorneal angle, PRC: Posterior radius of curvature, RNFL: Retinal nerve fiber layer.

have increased in Rs patients. In contrast to Jung et al. (7), the current study results showed that the ACD was enlarged in the Rs group. In the Jung et al. (7) study, a Pentacam device was used and 28 exotropia patients with a mean age of 6.7 years (range: 4 to 13 years) were included in the study. In the current study, an advanced version Pentacam HR device was used, and 38 patients with exotropia or esotropia with a mean age of 16.5 years (range: 8-30 years) were evaluated. Therefore, the different results could be attributed to the differences in the number of patients included in the studies, average age, and diagnoses, and that different devices were used. It can be predicted that after Rs surgery, the muscle tension force from the sclera to the cornea will decrease, and therefore the ACD and ICA 90° values will increase, whereas after Rt surgery, it can be predicted that the muscle tension force from the sclera to the cornea will increase, and the ACD and ICA 90° values will decrease. In the current study, it was observed that there was a widening of the ICA 180° after Rs surgery and narrowing after Rt surgery, but these changes were statistically insignificant.

There are studies in literature in which ASPs have been evaluated after strabismus surgery, and there are also studies that have evaluated PSPs (1, 5, 20). Inan et al. (21) evaluated the CT values of four different groups that underwent Rs surgery with OCT and reported a decrease in the short term. Atalay et al. (1), compared the postoperative CT values of patients who underwent rectus recession or resection (Group 1) with those who underwent oblique muscle myectomy (Group 2) and found that CT increased in Group 1. In a study in which RT and RNFL were evaluated after strabismus surgery, an increase was found in RNFL, but no significant change was found in CT (5). Likewise, in another study in which RT was evaluated on the first day after strabismus surgery, no significant difference was found between pre and postoperative values (20). In the current study, no statistically significant difference was determined between the pre and postoperative CT, RT, and RNFL values of both Rt and Rs patients. It seems that the inclusion of different numbers of patients and groups in the studies, the different interventions made to extraocular muscles, and the use of different devices may lead to different findings. Changes in mechanical forces transmitted through the sclera caused by the changed position of the extraocular muscles or postoperative inflammation and changes in the blood-retinal barrier may partially explain these findings. However, it is difficult to state an exact reason for these different findings.

The major limitations of this study were the relatively low number of patients and short study period. Patients with secondary strabismus and patients who had strabismus surgery other than the medial and lateral rectus muscles were excluded from the study. As only postoperative first month measurements were made and the long-term results were not evaluated, this decreased the impact of the study. However, despite all these limitations, it is important that significant results were obtained. To the best of our knowledge, this is the first study in the literature to have compared the pre-and postoperative values of ASPs and PSPs together after Rt or Rs surgery using Pentacam HR and OCT in patients with strabismus.

CONCLUSION

In conclusion, it should be known that there may be narrowing in the ACD and ICA after Rt surgery, and there may be enlargement after Rs surgery. Especially in patients with amblyopia or glaucoma, the changes in these parameters should be known before the surgery and the patients should be followed up accordingly after the surgery. For better documentation of the changes in ASPs and PSPs, there is a need for further studies with larger groups and longer follow-up periods.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Bolu Abant İzzet Baysal University Clinical Researches Ethics Committee (Date: 22.03.2022, Decision No: 131).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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