·Clinical Research·

# Comparison of surgically induced astigmatism in patients with horizontal rectus muscle recession

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## Abstract

**• AIM: To compare surgically induced astigmatism (SIA) following horizontal rectus muscle recession surgery between suspension recession with both the "hang – back" technique and conventional recession technique.**

**• METHODS: Totally, 48 eyes of 24 patients who had undergone horizontal rectus muscle recession surgery were reviewed retrospectively. The patients were divided into two groups. Twelve patients were operated on by the hang –back technique (Group 1), and 12 by the conventional recession technique (Group 2). SIA was calculated on the 1st wk, 1st and in the 3rd mo after surgery using the SIA calculator.**

**• RESULTS: SIA was statistically higher in the Group 1 all postoperative follow–up. SIA was the highest in the 1st wk, and decreased gradually in both groups.**

**• CONCLUSION: The suspension recession technique induced much more SIA than the conventional recession technique. This difference also continued in the following visits. Therefore, the refractive power should be checked postoperatively in order to avoid refractive amblyopia. Conventional recession surgery should be the preferred method so as to minimize the postoperative refractive changes in patients with amblyopia.**

**• KEYWORDS:** surgically induced astigmatism; horizontal rectus; recession

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## INTRODUCTION

Refractive changes after strabismus surgery have been reported in the literature [1-5]. Some of the researchers thought that these refractive changes were transient and non-significant [6,7]. However, some researchers advocate that significant refractive changes occur after strabismus surgery[8,9]. There are different theories about the change in refraction after strabismus surgery. These theories include torsional effects of oblique muscle surgery, changes in the lens curvatures may be affected by changes in the circulation of the ciliary body, scleral wound healing, orbital and eyelid edema, and intraocular pressure changes. These are correlated with corneal power changes associated with due to changes in muscle tension[10-14].

The effect of strabismus surgery on corneal power has been studied extensively, but there are no studies about the effect of strabismus surgery on surgically induced astigmatism (SIA) in the literature. The current retrospective study was performed to further examine the role of horizontal muscle recession surgery on SIA. We compared SIA following horizontal rectus recession surgery between the suspension recession (hang-back) technique and the conventional recession surgery technique.

## SUBJECTS AND METHODS

We retrospectively reviewed the medical records of the patients who had undergone horizontal rectus muscle recession surgery between December 2011 and August 2013. Exclusion criteria for this study included patients with amblyopia, ocular or neurologic diseases, previous history of ocular surgery, coexisting vertical strabismus, extraocular muscle paralysis, nystagmus, corneal opacities, follow-up by duration less than 3mo, poor cooperation to corneal topography. Informed consent was obtained from the patients. The study was approved by Adnan Menderes University's local ethics committee and was performed according to the Declaration of Helsinki.

Totally, 48 eyes of 24 patients were enrolled in this study. The patients in both groups were independent from each other. The patients were divided in the two groups. Horizontal rectus surgery was performed with a suspension recession surgery technique (Group 1; 24 eyes, 12 patients)

and was performed with a conventional recession surgery technique (Group 2; 24 eyes, 12 patients). Age, gender, prism cover test, best corrected visual acuity, slit lamp examination, and corneal topography were reviewed and analyzed.

Corneal topography was performed using the Orbscan II (Bausch & Lomb, Rochester, NY, USA) preoperatively, on the 1st wk, and the 1st and 3rd mo postoperatively.

Strabismus surgery was planned according to the amount of deviation, and performed by one surgeon (HÇ). SIA was evaluated with SIA calculator version 3.1, a free software program (http://www.insighteyeclinic.in/SIA_calculator.php). Data analysis was performed with the SPSS® (Statistical Package for Social Sciences), version 18.0. The Kolmogorov-Smirnov test was used to assess the normality of numeric variables. For the normally distributed variables, a comparison between the two groups was made by the independent sample *t*-test, and the results were expressed as a mean standard deviation. For the non-normally distributed variables, the comparison between the two groups was made with the Mann-Whitney *U*-test, and the descriptive statistics were expressed as median (25-75 percentiles). Significance was defined as $P<0.05$. The Keratometric measurements were evaluated with the SIA calculator version 3.1. In repeatability analysis, any astigmatism smaller than 0.16 diopters (D) was accepted in the "variable interval" which changes according to device and operator. The real-induced changes in vectorial astigmatism greater than 0.16 D were defined as SIA.

## RESULTS

Clinical findings of the patients are shown in Table 1. There were 24 eyes of 12 patients (7 males and 5 females) with the mean age of 12.83±5.9y in Group 1 and there were 24 eyes of 12 patients (8 males and 4 females) with the mean age of 12.75±5.7y in Group 2. In our study the mean age and age range of the groups were similar. There were no statistically difference in terms of age, sex, deviation at near and far, amount of recession and operated muscle.

Sixteen eyes underwent medial rectus (MR) recession and 8 eyes underwent lateral rectus (LR) recession (Group 1). Eighteen eyes were underwent MR recession and 6 eyes underwent LR recession (Group 2). Preoperatively the prism cover test revealed 48.33±8.69 PD and 49.17±9.74 PD at near deviation, 47.22±8.82 PD and 48.21±8.73 PD at far deviation in Groups 1 and 2, respectively. The mean preoperative keratometric values in steep axis (KS) were 44.28 (41.55-45.78) D and 44.21 (43.6-45.00) D in Groups 1 and 2, respectively. The mean preoperative keratometric values in flat axis (KF) were 42.58 (39.38-44.28) and 43.15 (42.43-43.80) in Groups 1 and 2, respectively. The mean preoperative keratometric differences (KD) were 1.79 (1.03-2.63) D in Group 1 and 1.81 (1.10-2.40) D in Group 2. The astigmatisms were within the rule. There was no statistical difference in terms of preoperative keratometric values between the groups.

**Table 1 Clinical findings of the patients** $\bar{x} \pm s$

| Parameters | Suspension group | Conventional group |
|---|---|---|
| No. of patients | 12 | 12 |
| Age | 12.83±5.9 | 12.75±5.7 |
| Sex (M/F) | 7/5 | 8/4 |
| Deviation at near (PD) | 48.33±8.69 | 49.17±9.74 |
| Deviation at far (PD) | 47.22±8.82 | 48.21±8.73 |
| MR recession (eye) | 16 | 18 |
| LR recession (eye) | 8 | 6 |
| Amount of recession (mm) | 6.21±0.49 | 6.13±0.51 |

PD: Prism diopters; MR: Medial rectus; LR: Lateral rectus.

**Table 2 Keratometric values of the patients** (D)

| Parameters | Suspension group | Convensional group |
|---|---|---|
| Preop. KS | 44.28 (41.55-45.78) | 44.21 (43.60-45.00) |
| Preop. KF | 42.58 (39.38-44.28) | 43.15 (42.43-43.80) |
| Preop. KD | 1.79 (1.03-2.63) | 1.81 (1.10-2.40) |
| Postp.1st wk KS | 43.91 (42.15-45.75) | 44.3 (43.43-45.13) |
| Postp.1st wk KF | 41.86 (39.93-43.70) | 43.14 (42.35-43.80) |
| Postp.1st wk KD | 1.99 (1.15-2.90) | 1.89 (1.23-2.63) |
| Postp.1th mo KS | 43.63 (40.93-45.98) | 44.23 (43.10-45.08) |
| Postp.1th mo KF | 41.62 (38.45-43.58) | 43.12 (42.5-43.90) |
| Postp.1th mo KD | 2.02 (1.03-2.88) | 1.87 (1.20-2.60) |
| Postp.3rd mo KS | 44.11 (42.13-45.65) | 44.31 (43.20-45.33) |
| Postp.3rd mo KF | 42.16 (39.83-43.90) | 43.27 (42.70-44.05) |
| Postp.3rd mo KD | 1.95 (1.10-2.85) | 1.78 (1.13-2.50) |

KS: Steep keratometric values; KF: Flat keratometric values; KD: Keratometric difference values; The descriptive statistics were expressed as median (25-75 percentiles). There was no difference in preoperative and postoperative keratometric values between the two groups.

Keratometric values are seen in Table 2 preoperatively and in the 1st wk, 1st mo and 3rd mo postoperatively. KD was higher in Group 1 in all postoperative periods, and was seen to be increasing in 1st mo and then decreased in both groups (Figure 1). Although there was no difference statistically in terms of keratometric values between the groups, SIA values were statistically higher in Group 1. After the 1st wk, they were found 0.87 (0.66-1.12) and 0.64 (0.45-0.74) D in Group 1 and 2, respectively ($P=0.01$). In the 1st mo, it was found to be 0.64 (0.40-0.83) D in Group 1 and 0.41 (0.20-0.54) D in Group 2 ($P=0.004$). At the end of the follow-up period of 3mo, SIA was found 0.44 (0.29-0.54) D and 0.25 (0.12-0.29) D in Groups 1 and 2, respectively ($P=0.005$) (Figure 2). We analyzed SIA for MR recession patients and values are shown in Figure 3. SIA values were found to be high in suspension group for all follow ups and this difference was statistically significant (Figure 3).

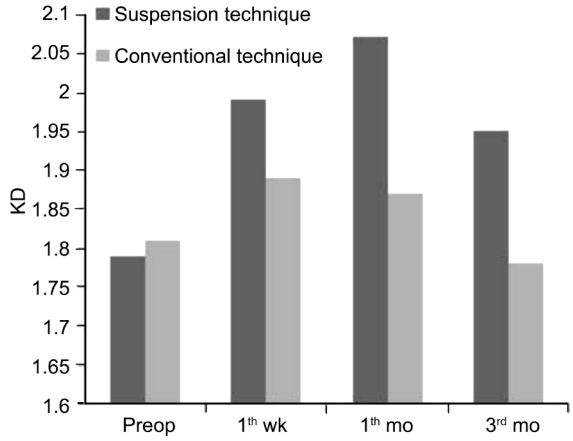


**Figure 1 Preoperative and postoperative KD** KD: Keratometric difference. KD was higher in suspension group all postoperative period. But this difference wasn't statistically significant.

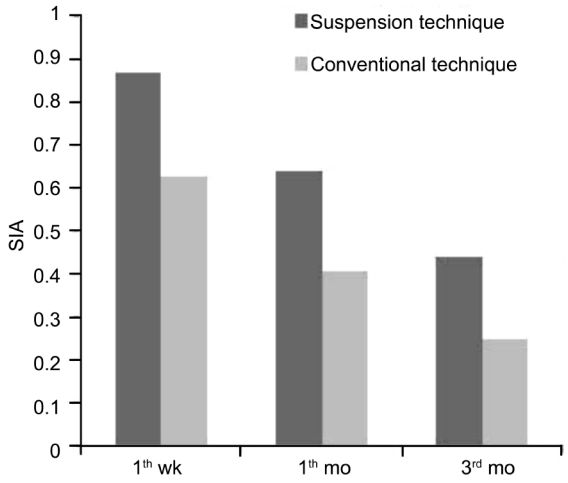


**Figure 2 Amount of SIA** SIA: Surgically induced astigmatism. SIA was higher in suspension group all postoperative follow-ups and this difference was statistically significant.

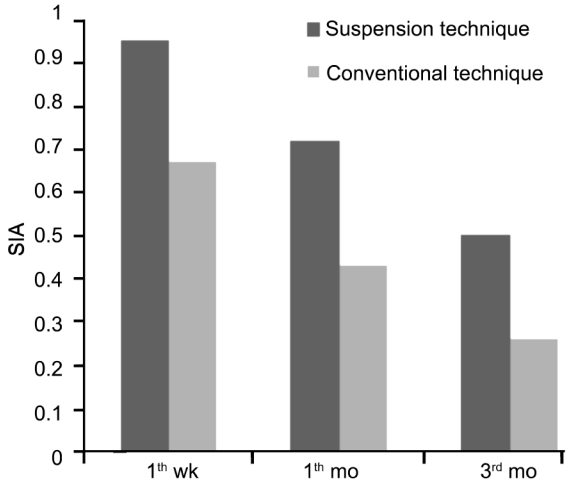


**Figure 3 Amount of SIA for medial rectus recession** SIA: Surgically induced astigmatism. SIA was higher in suspension group all postoperative follow-ups and this difference was statistically significant. *P* values were 0.004, 0.001 and 0.002 for 1st wk, 1st mo and 3rd mo, respectively.

## DISCUSSION

In this study, we evaluated SIA following the horizontal rectus muscle recession in a 3mo follow-up period. We found statistically significant difference in the postoperative SIA values between the conventional recession technique and the suspension recession technique.

Astigmatism can be measured by keratometer. However, the SIA needs to be calculated. We used the "SIA Calculator Version 3.1" to evaluate SIA.

Astigmatic changes after recession horizontal rectus muscles or horizontal rectus muscle recession-resection procedures were previously reported [10-14]. There are different theories about the change in astigmatism after strabismus surgery. The change of extraocular muscle tension on corneal power is seen as the most important factor[2].

There are many publications that describe the hang-back suspension technique. Suspension technique has some advantages when compared to conventional technique. These include shorter surgery duration, less risk of scleral perforation, better exposure of scleral sutures[15].

Mohan and Sharma[16] found that conventional bilateral lateral rectus recessions success rate were more than hang-back recessions in patients with true divergence excess intermittent exotropia. On the other hand, many studies report that the hang-back technique is as effective as the conventional rectus muscle recession technique[17-19].

Although many studies have evaluated the efficacy between the two techniques, there are few studies that have been carried out on the impact of astigmatism. Betts and Olitsky[20] selected one eye to randomly underwent strabismus surgery with suspension technique, and the other eye underwent strabismus surgery using the conventional technique. They measured the keratometric values in the operating room immediately prior to and immediately after the operation, and found that the suspension recession technique induced less corneal astigmatism [20]. Unlike our study, they only studied corneal curvature changes in the early perioperative period in the operating room; they did not follow up on the patients after the long postoperative period in terms of astigmatism. In the perioperative period, there are many reasons that may affect astigmatism such as inflammation, kemosis, tissue edema, irritating sutures, and patients' discomfort. It should be measured in the late postoperative period also. On the other hand the method which was used in their prospective study is a valid approach to compare the results based on the same tissue response and ocular conditions.

Rajavi *et al* [21] evaluated refractive error changes following horizontal muscle recessions, and found statistically significant differences in some aspects; however, these

differences did not seem to be important clinically. They did not recommend early cycloplegic refraction after the horizontal muscle recessions in order to discover any surgically induced refractive changes. They recommended that a cycloplegic refraction is required in all cases 3mo after the operation.

Chun *et al* [22] study evaluated changes in the induced astigmatism by lateral rectus recession. They found that, the larger recessions had more induced astigmatism in the 1st wk postoperatively. However, there was no statistically significant difference in the induced astigmatism between the two groups. In our study the horizontal rectus muscles recession range was very small and therefore we think that the small amount of recession didn't influence the amount of astigmatism and other parameters which Chun *et al*[22] mentioned in their study.

According to international practice, even by performing the same amount of recession on MR and LR muscles, the results may not be the same. We analyzed also SIA values separately for MR and LR recession in the same group. In the MR recession group, SIA values were found to be high in suspension group for all follow-ups and this difference was statistically significant (Figure 3). Unfortunately, we couldn't evaluate these parameters for LR recession cases; because of small number of patients.

The adjustable suture technique is partially a similar technique to the suspension recession technique. Eustis *et al*[23] found more tissue response to surgery in patients with adjustable sutures. After strabismus surgery using the adjustable suture technique, some non-serious complications and temporary problems can occur, such as conjunctival dehiscence, suture granuloma or cyst, conjunctival edema and/or hyperemia[24-26].

In suspension recession technique, remodeling may take longer due to delayed scleral wound healing, and other tissue responses to the suture between the conjunctiva and sclera. In addition, the long suture material in the subconjunctival space (not buried in the sclera) may cause increased reactions when compared to other techniques. In the conventional technique, there is no suture between the new insertion point and the cornea in the subconjunctival space.

There are some limitations in our study; the groups are paired for age and age ranges are similar. Although age ranges could be more homogenous in each group itself. There are three patients around 6 years old in each group and there are two patients around 19 years old in each group. SIA may be influenced by age at operation. Further prospective studies with more homogenous group in terms of age are needed.

In conclusion, our study showed that the suspension recession technique caused much more SIA than the conventional horizontal rectus recession technique. In addition, this difference continues during the three month follow-up. Because these refractive differences may increase the astigmatism, this may affect amblyopic patients. Thus, the refractive power should be checked postoperatively, and conventional recession surgery should be the preferred technique in patients with amblyopia.

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**REFERENCES**

1 Noh JH, Park KH, Lee JY, Jung MS, Kim SY. Changes in refractive error and anterior segment parameters after isolated lateral rectus muscle recession. *J AAPOS* 2013;17(3):291-295

2 Hong SW, Kang NY.Astigmatic changes after horizontal rectus muscle surgery in intermittent exotropia. *Korean J Ophthalmol* 2012;26 (6): 438-445

3 Bagheri A, Farahi A, Guyton DL. Astigmatism induced by simultaneous recession of both horizontal rectus muscles. *J AAPOS* 2003;7(1):42-46

4 Mun GH, Heo H, Park SW, Park YG. The changes of corneal astigmatism and refraction after horizontal rectus muscle surgery in intermittent exotropia. *J Korean Ophthalmol Soc* 2010;51(4):581-587

5 Emre S, Cankaya C, Demirel S, Doganay S. Comparison of preoperative and postoperative anterior segment measurements with Pentacam in horizontal muscle surgery. *Eur J Ophthalmol* 2008;18(1):7-12

6 Killer HE, Bahler A. Significant immediate and long-term reduction of astigmatism after lateral rectus recession in divergent Duane's syndrome. *Ophthalmologica* 1999;213(3):209-210

7 Jung JH, Choi HY. Comparison of preoperative and postoperative anterior segment measurements with Pentacam in strabismus surgery. *J Pediatr Ophthalmol Strabismus* 2012;49(5):290-294

8 Snir M, Nissenkorn I, Buckman G, Cohen S, Ben-Sira I. Postoperative refractive changes in children with congenital esotropia: a preliminary study. *Ophthalmic Surg* 1989;20(1):57-62

9 Dottan SA, Hoffman P, Oliver MD. Astigmatism after strabismus surgery. *Ophthalmic Surg* 1988;19(2):128-129

10 Kushner BJ. The effect of oblique muscle surgery on the axis of astigmatism. *J Pediatr Ophthalmol Strabismus* 1986;23(6):277-280

11 Kim B, Park SH, Shin SY. The changes in the cornea and anterior chamber after lateral rectus muscle recession in intermittent extropia. *J Korean Ophthalmol Soc* 2012;53(1):127-132

12 Kitthaweesin K, Singhakul S. Effect of horizontal strabismus surgery on the astigmatism. *J Med Assoc Thai*2007;90:744-747

13 Yoo C, Chang MH, Song JS, Kim SH. Changes in intraocular pressure during strabismus surgery. *Can J Ophthalmol* 2010;45:602-605

14 Denis D, Bardot J, Volot F, Saracco JB, Maumenee IH. Effects of strabismus surgery on refraction in children. *Ophthalmologica* 1995;209 (3):136-140

15 Orlin A, Mills M, Ying GS, Liu C. A comparison of hang-back with conventional recession surgery for exotropia. *J AAPOS* 2007;11 (6): 597-600

16 Mohan K, Sharma A. A comparison of ocular alignment success of

hang-back versus conventional bilateral lateral rectus muscle recession for true divergence excess intermittent exotropia. *J AAPOS* 2013;17(1):29-33

17 Spierer O, Spierer A. Comparison of hang-back and conventional bimedial rectus recession in infantile esotropia. *Graefes Arch Clin Exp Ophthalmol* 2010;248(6):901-905

18 Park J, Lee JJ, Lim EH, Lee JH, Jin KH, Kim US. Effect of fibrin glue as an adjuvant to hang-back surgery. *BMC Ophthalmol* 2012;12:14

19 Suh YW, Park JH, Cho YA. The effect of botulinum toxin injection on the hang-back recession of rectus muscles. *Graefes Arch Clin Exp Ophthalmol* 2011;249(6):921-924

20 Betts C, Olitsky S. Corneal astigmatic effects of conventional recession vs suspension recession ("hang-back") strabismus surgery: a pilot study. *Binocul Vis Strabismus Q* 2006;21(4):211-213

21 Rajavi Z, Mohammad Rabei H, Ramezani A, Heidari A, Daneshvar F. Refractive effect of the horizontal rectus muscle recession. *Int Ophthalmol* 2008;28(2):83-88

22 Chun BY, Kim HK, Kwon JY. Comparison of magnitude of astigmatism induced by lateral rectus recession. *Optom Vis Sci* 2010;87(1):61-65

23 Eustis HS, Elmer TR Jr, Ellis G Jr. Postoperative results of absorbable, subconjunctival adjustable sutures. *J AAPOS* 2004;8(3):240-242

24 Mocan MC, Azar NF. Amniotic membrane transplantation for the repair of severe conjunctival dehiscence after strabismus surgery with adjustable sutures. *Am J Ophthalmol* 2005;140:533-534

25 Escardo-Paton JA, Harrad RA. Duration of conjunctival redness following adult strabismus surgery. *J AAPOS* 2009;13:583-589

26 Liebermann L, Hatt SR, Leske DA, Holmes JM. Adjustment versus no adjustment when using adjustable sutures in strabismus surgery. *J AAPOS* 2013;17(1):38-42