

# Surgical Effect of Unilateral Medial Rectus Resection According to Tendon Width in Recurrent Exotropia

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## Research Article

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# Abstract

## Background

To investigate the dose response according to tendon width of the medial rectus in patients with recurrent exotropia who underwent unilateral medial rectus resection.

## Methods

Patients with basic recurrent exotropia after bilateral lateral rectus recession were included. All patients underwent unilateral medial rectus resection according to the preoperative angle of deviation. Under general anesthesia, the tendon width of the medial rectus in the operated eye was measured. The patients were divided into 2 groups (narrow and wide) according to the median value of the tendon width of the medial rectus. The angle of deviation at postoperative day 1 was measured. The dose response was calculated based on the amount of correction and resection.

## Results

This study included 38 patients. Age and preoperative angle of deviation were  $11.0 \pm 3.0$  years (range, 6 – 19 years) and  $21.3 \pm 3.2$  prism diopters (PD; range, 15 – 25 PD), respectively. Tendon width of the medial rectus was  $7.6 \pm 0.7$  mm (range, 6.0 - 8.5 mm) and the median value of tendon width was 7.5 mm. The dose response was  $4.6 \pm 0.8$  PD/mm (range, 2.4 - 5.6 PD/mm). The dose response was significantly greater in the wide than in the narrow tendon width group ( $p < 0.001$ ). Tendon width of the medial rectus was significantly correlated with age, the preoperative angle of deviation and surgical dose response (all,  $p < 0.05$ ).

## Conclusion

The tendon width of the medial rectus could be a predictor for estimating the surgical dose response when considering unilateral medial rectus resection in patients with the moderate angle of recurrent exotropia.

## Background

In recurrent exotropia after bilateral lateral rectus recession, unilateral or bilateral medial rectus resection is often considered as reoperation surgery.<sup>1, 2</sup> The surgical amount was usually decided according to the surgical standard table in patients with exotropia.<sup>3</sup> The surgical amount of medial rectus resection is based on surgeon experiences, type of exotropia and lateral incomitance or refractive errors.<sup>4, 5</sup> However, and there was some variability in the surgical effect of medial rectus resection.<sup>1, 6, 7</sup>

One of the authors (S.H.K) previously reported that the tendon width of the lateral rectus is an indicator in patients with intermittent exotropia.<sup>8-10</sup> They demonstrated that anatomical changes of tendon width according to preoperative angle and age could affect the surgical outcome in intermittent exotropia. However, to the best of our knowledge, there has been no study of the clinical effects of tendon width of the medial rectus on the surgical dose response.

Our study aimed to investigate the surgical dose response according to the tendon width of the medial rectus in patients with recurrent exotropia who underwent unilateral medial rectus resection.

## Methods

The study protocol was approved by the Korea University Medical Center Institutional Review Board and adhered to the tenets of the Declaration of Helsinki.

Written informed consent and the study were approved by the Research Ethics Committee at the Korea University Medical Center. The informed consent to participate in the study was obtained from participants or their parent or legal guardian in case of

children under 16. A retrospective study was conducted of patients who had undergone a unilateral medial rectus resection between January 2014 and December 2017 for basic recurrent exotropia that had developed after bilateral lateral rectus recession as primary surgery. Patients with a disparity in the angle of deviation greater than 10 prism diopters (PD) at distance and near, oblique dysfunction, amblyopia, surgical history of medial rectus resection or neurologic deficits were excluded.

All surgeries were performed by a single surgeon (S.H.K). Under general anesthesia, fornix incision was made. The medial rectus muscle was completely exposed using muscle hook. Before dissection of the muscle tendon from the sclera, the tendon width of the medial rectus of the operated eye near the insertion was measured with calipers. The medial rectus was then dissected from the surrounding intermuscular septum. The suture was passed at the desired location from insertion, and the medial rectus was resected. The medial rectus was reattached to the original insertion using the long tunnel, and cross-sword technique and the conjunctiva was sutured.

Age at surgery, sex, interval after primary surgery, the angle of deviation and tendon width of the medial rectus were measured. The angle of deviation was measured using the alternative prism cover test. The pre- and postoperative angle of deviation at postoperative day 1 was measured. The amount of correction was calculated as the difference between the pre- and postoperative angle of deviation at a distance. The surgical dose response (PD/mm) was also calculated according to the amount of the correction and the resected medial rectus.

We divided the patients into 2 groups according to the median value of tendon width of the medial rectus as followings: narrow (less than the median value) or wide group (greater than the median value).

Data were analyzed using SPSS software version 21.0 (SPSS Inc., Chicago, IL, USA). A Mann – Whitney test was used to compare measurements between 2 subgroups. A Linear regression test was used to analyze the correlation of tendon width of the medial rectus with other measurements. A p value  $\leq 0.05$  was considered significant.

## Results

A total of 38 patients were included in this study. Age at surgery was  $11.0 \pm 3.0$  years (range, 6 -19 years) and 9 patients (23.7%) were male. Interval after primary surgery was  $16.0 \pm 4.2$  months (range, 10 – 24 months) and preoperative angle of deviation was  $21.3 \pm 3.2$  PD (range, 15 – 25 PD) at a distance. Tendon width of the medial rectus was  $7.6 \pm 0.7$  mm (range, 6.0 - 8.5 mm), and the amount of resection was  $4.8 \pm 0.7$  mm (range, 3 – 6 mm). The angle of deviation at postoperative day 1 was  $-0.5 \pm 1.6$  PD (range, -5 – 2 PD). Minus value means esodeviation. The calculated surgical dose response was  $4.6 \pm 0.8$  PD/mm (range, 2.4 - 5.6 PD/mm). Detailed basic demographics are described in Table 1.

The median value of tendon width of the medial rectus was 7.5 mm. There were 12 and 26 patients in the narrow and wide groups, respectively. The tendon width of the medial rectus was  $6.8 \pm 0.4$  mm (range, 6.0 - 7.3 mm) in narrow group and  $7.6 \pm 0.4$  mm (range, 7.5 - 8.5 mm) in the wide group. The preoperative angle of deviation was  $19.6 \pm 2.6$  PD (range, 15 – 25 PD) in the narrow group and  $22.0 \pm 3.2$  PD (range, 16 – 25 PD) in wide group. The dose response at postoperative day 1 was  $3.9 \pm 0.9$  PD/mm (range, 2.4 - 5.3 PD/mm) in the narrow group and  $4.9 \pm 0.5$  PD/mm (range, 4.0 - 5.6 PD/mm) in the wide group. The dose response was significantly larger in the wide group than in the narrow group ( $p < 0.01$ ). Comparison of clinical measurements between narrow and wide group is described in Table 2.

Clinical correlations of tendon width of the medial rectus with age, preoperative angle of deviation, dose response and interval after primary surgery were analyzed. The tendon width of the medial rectus was positively correlated with age ( $r = 0.50$ ,  $p < 0.01$ ) and preoperative angle of deviation ( $r = 0.41$ ,  $p < 0.01$ ). The tendon width of the medial rectus was significantly correlated with dose response ( $r = 0.38$ ,  $p = 0.01$ ). However, the tendon width of the medial rectus was not correlated with interval after primary surgery ( $r = -0.07$ ,  $p = 0.56$ ) (Figure 1).

## Discussion

In this study, dose responses were greater in patients with resection of wide tendon width of the medial rectus than in those with narrow tendon width of the medial rectus. The tendon width of the medial rectus was a correlation with age at surgery, preoperative angle of deviation and surgical dose response.

One of the authors previously reported the clinical importance of the tendon width of the lateral rectus as a predictor of surgical effect in intermittent exotropia.<sup>8-10</sup> The mean tendon width of the lateral rectus was 8.3 mm (range, 6.5 - 9.5 mm), in patients aged 7 to 11 years who underwent unilateral lateral rectus recession.<sup>8</sup> The surgical effect of lateral rectus recession was greater in patients with narrow tendon width of the lateral rectus.<sup>8</sup> Additionally, the tendon width of the lateral rectus as a prediction of surgical effect could be applied to patients greater than 5 years of age and with less than 25 PD of exotropia.<sup>9, 10</sup> In this study, the mean tendon width of the medial rectus was  $7.6 \pm 0.7$  mm (range, 6.0 - 8.5 mm) which is comparable with our previous study.

The dose responses were variable in this study. In this study, the dose responses ranged from 2.4 to 5.6 PD/mm after medial rectus resection for recurrent exotropia. Suh et al.<sup>11</sup> reported that the surgical dose response of unilateral medial rectus resection in patients with recurrent exotropia varied from 2.0 to 6.7 PD/mm. Their results were in agreement with our study. Variability of the surgical effect of the medial rectus resection could have several possible explanations. We speculated that anatomical change of the medial rectus including thickness, width or tonus could induce a variable surgical outcome. The tendon width of the medial rectus was correlated with age and preoperative angle of deviation in this study. Bielshowsky reported that the functional contracture from anatomically changed extraocular muscles is retained by excessive innervation.<sup>12</sup> The tension could be needed to maintain the eye position<sup>13</sup>, inducing the mechanical stress to the extraocular muscle. One possibility that the medial rectus as an antagonist of the lateral rectus might be stretched passively and wider during the progression of exodrift after primary surgery. Thus, this anatomical change could increase the tendon width of the medial rectus and might affect dose response. In this study, resection of wider tendon width of the medial rectus had a larger surgical dose response than the narrow tendon width of the medial rectus. The tendon width of the medial rectus was proportional to surgical dose response in this study.

Several factors are influencing the amount of surgery necessary to correct intermittent exotropia. Amblyopia, lateral incomitance, high AC/A ratio and refractive error which could affect surgical outcome were considered.<sup>4, 5, 14-16</sup> Measurement of tendon width of the medial rectus could apply to surgery in patients with recurrent exotropia who underwent unilateral medial rectus resection.

There were limitations in this study. First, the study design was retrospective, and only a small number of patients were included. Second, patients under the age of 6 not included in this study. In a previous study, Choi et al. reported that measurement of tendon width of the lateral rectus could apply to patients greater than 5 years of age due to rapid postnatal eye growth until 5 years of age.<sup>10</sup> Third, patients with a large angle of deviation and bilateral medial rectus resection were excluded. Further studies are required to elucidate the surgical effect of tendon width and various surgical methods on eyes with the large angle of deviation.

## Conclusions

The tendon width of the medial rectus could be an excellent anatomical predictor for estimating the surgical dose response considering the medial rectus resection in patients with recurrent exotropia.

## Declarations

### List of abbreviations

PD: prism diopters, AC/A: Accommodative convergence/ accommodation

### Ethics and consent to participate

This study adheres to the tenets of the Declaration of Helsinki and approved by the Korea University Medical Center Institutional Review Board. Written informed consent and the study were approved by the Research Ethics Committee at the Korea University Medical Center.

### **Consent to publish**

Not applicable

### **Competing interests**

The authors have no financial interest in this study.

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There is no funding for this study.

### **Author's contribution**

S.H.K suggested concept of study. S.G.H performed to conduct study. S.G.H collected data in this study. The measurements were confirmed by S.H.K. Analysis data and interpretation of data were performed by S.G.H and S.H.K. S.G.H wrote the manuscript. S.H.K provided a critical review of the manuscript. All authors approved the manuscript for submission.

### **Availability of data and materials**

All the data supporting the conclusions of this article is included within the article

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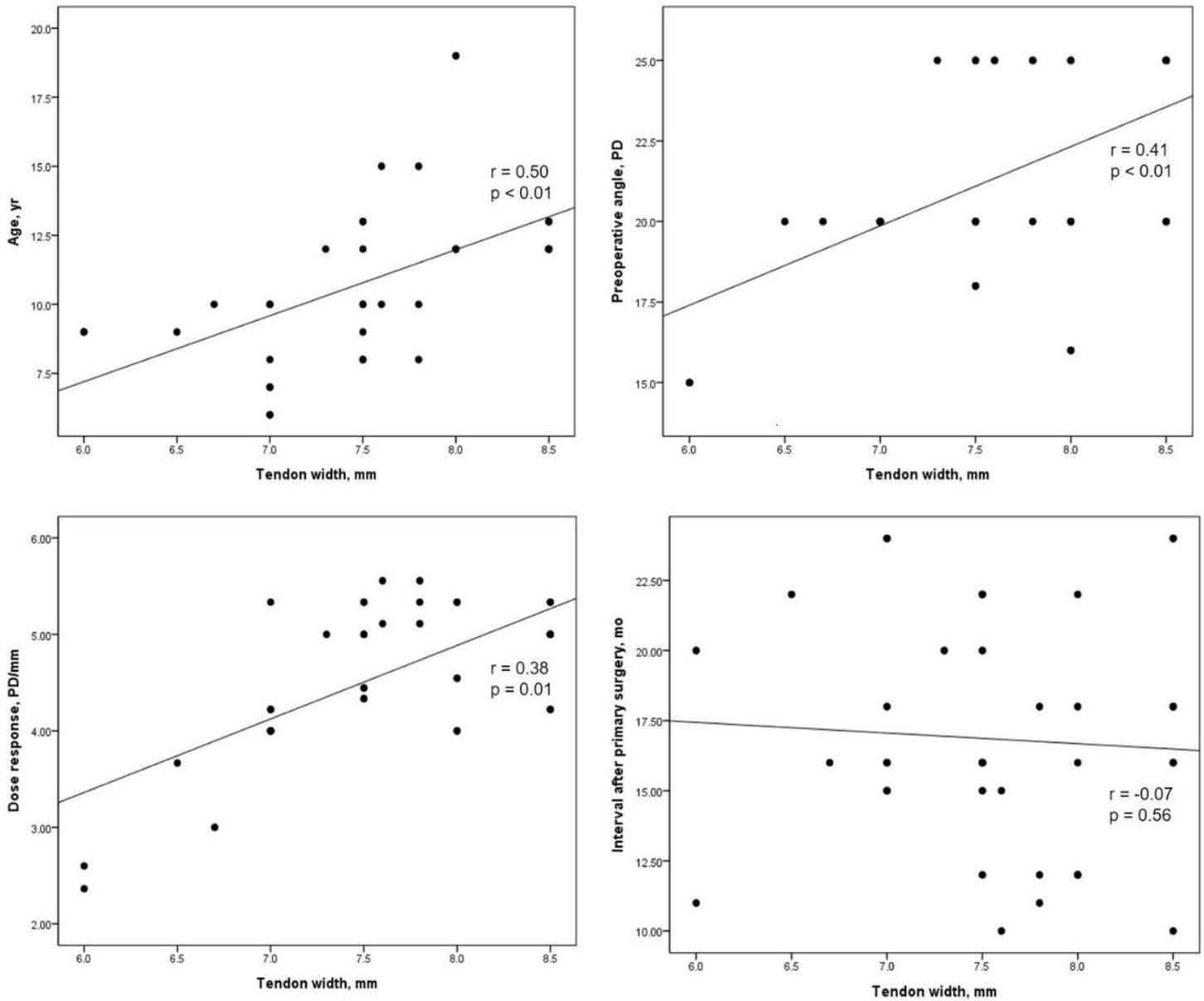
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## Figures



**Figure 1**

Correlation of the tendon width of the medial rectus and age, preoperative angle, surgical dose response and interval after primary surgery.