

Successful Outcomes Of Half-Tendon Width Vertical Transposition For Managing Large V-Pattern Exotropia in Anisometropic Amblyopia

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Abstract

Introduction: Strabismus patterns commonly occur among routine strabismus patients, though they are rarely discussed in detail. A or V patterns are found in 15-25% of all horizontal strabismus cases. Managing pattern strabismus can be challenging, as it requires correcting both the horizontal deviation and the vertical pattern. Full-tendon width vertical displacement provides approximately 25 PD of correction and is reserved for extremely large V-patterns but may cause significant torsional changes. Herein, we report a successful surgical outcome of half-tendon width vertical transposition in a case of large V-pattern exotropia.

Methods: A 27-year-old man presented with progressive squinting in his right eye, occasionally involving his left eye, and difficulty focusing with the right eye. A cover test revealed alternate exotropia. V-pattern was diagnosed using Krinsky and PCT tests, showing 50 PD base-in for upgaze, 35 PD for both distance and near, and 25 PD for downgaze, with no movement of the deviated eye. Ocular motility showed no inferior oblique overaction. For patterns >30 PD, full-tendon width transposition is ideally effective in collapsing the pattern. However, there are several complications associated with performing full-tendon width transposition. Therefore, a half-tendon width vertical transposition of the lateral and medial rectus muscles of the right eye was performed. The patient was followed for 6 months postoperatively, and the Hirschberg test showed orthophoria.

Results: In the absence of oblique overaction, the vertical transposition of the horizontal muscle using MALE procedure can be considered for V-pattern exotropia. A half-tendon width vertical transposition with MALE procedure was performed on our patient. The surgical outcome demonstrated orthophoria in all gazes and a successful collapse of the V pattern. No complications like torsion and diplopia were observed in our patient.

Conclusion: MALE procedure with full-width transposition provides greater improvement and is usually reserved for larger V patterns. In our patient, we successfully performed a vertical transposition with a half-tendon width LR recession and MR resection therefore half-tendon transposition can produce favourable outcomes.

Keywords: strabismus, patternstrabismus, V-pattern, exotropia, vertical incomitance, transposition, MALE procedure

SUMMARY

A 27-year-old man presented with progressive squinting in his right eye, occasionally involving his left eye, accompanied by difficulty focusing with the right eye. A cover test revealed alternate exotropia. V-pattern was identified using Krinsky and prism cover test (PCT), showing 50 PD base-in in upgaze, 35 PD at both distance and near in primary position, and 25 PD in downgaze, with no movement of the deviated eye was observed. Ocular motility showed no inferior oblique overaction. For V-patterns with greater than 30 PD, full-tendon width transposition is ideally effective in collapsing the pattern. However, there may be complications associated with performing full-tendon width transposition. Therefore, a half-tendon width vertical transposition of the lateral and medial rectus muscles in the right eye was performed. The patient was followed for 6 months postoperatively, and the Hirschberg test showed orthophoria.

I. Introduction

Strabismus is a misalignment of the visual axis that affects 2-3% of the population and can lead to a loss of binocular vision. Although strabismus patterns are common in routine strabismus patients, they are rarely discussed in depth. The term "pattern strabismus" denotes a significant difference in the size of horizontal deviations in defined positions of upgaze and downgaze. Classically, it includes "A" and "V" patterns, where, by convention, the difference between upgaze and downgaze must exceed 10 prism diopters (PD) for "A" patterns and 15 PD for "V" patterns. In recent years, this term has expanded to include other patterns with significant differences in primary gaze, upgaze, and downgaze, such as Y, X, arrow, and lambda patterns.^{1,2,3,4}

The causes of strabismus in adults are numerous. Challenges to ocular alignment common in the pediatric population can persist, and new conditions that destabilize alignment may develop due to aging, vision loss, myopia, endocrine and neurological disorders, or iatrogenic and non-iatrogenic trauma to the globe or orbit. Many theories have been proposed regarding its etiology. The most widely accepted theory, proposed by Knapp, attributes pattern strabismus primarily to oblique muscle dysfunction, with overacting inferior obliques in "V" patterns and overacting superior obliques in "A" patterns. However, the exact mechanism of pattern strabismus remains poorly understood.^{5,6}

A study by Laughton et al. found a nearly identical prevalence of horizontal strabismus between males (2.558%) and females (2.582%), as well as similar rates of esotropia (1.386% in males vs. 1.377% in females) and exotropia (1.035% in males vs. 1.043% in females). A and V patterns are observed in 15-25% of all horizontal strabismus cases, with the V pattern being the most common overall.⁴

Detection of pattern deviation in cases of exotropia or horizontal deviation in general is very important before determining surgical intervention. Unrecognized patterns may lead to postoperative overcorrection or undercorrection, potentially necessitating additional surgeries to address undesirable outcomes.⁷

The management of pattern strabismus can be challenging, as it requires correction of both the horizontal deviation and the vertical pattern. Correction is necessary only if the pattern is significant (as described above) or if the patient experiences symptoms in the direction of the largest deviation. The type of surgery is determined by the underlying pathophysiology of the pattern and is directed toward the implicated extraocular muscle. Knapp's studies on horizontal recti surgery with vertical displacement of insertions advocate for the vertical displacement of horizontal recti to correct pattern strabismus. When there is a pattern without oblique muscle overaction, upshifts or downshifts of the horizontal recti can be used to collapse the pattern. The muscle insertion should be shifted in the direction where its effect needs to be weakened. For example, in a V-pattern, the medial rectus insertion is shifted downward to enhance its effect in upgaze and decrease it in downgaze.⁵ This case aims to illustrate the successful outcomes of the medial rectus muscle to the apex, lateral rectus muscle to the empty space (MALE) procedure with half-tendon width vertical transposition of the lateral rectus muscle tendon recession and medial rectus resection.

II. Case Illustration

We present a case of V-pattern exotropia in a 27-year-old man, with longstanding V-pattern exotropia. The patient reported a right-eye deviation since 5 years of age, which had progressively increased over time. Occasionally, the deviation was also observed in his left eye without an identifiable precipitating factor. In addition, difficulty in maintaining fixation with the right eye has been reported and preferentially using the left eye for fixation. Currently, complaints of double vision, headaches, redness, soreness, or watery eyes were denied. There was no history of spectacle use, ocular trauma, or previous ocular surgery or any systemic or ocular diseases.

On ophthalmologic examination, the visual acuity in the right eye was 6/120 with correction of S-6.50 C-0.50 X35° which improved to 6/12 without improvement with pinhole testing. In the left eye, visual acuity was 6/12, with correction S-0.75 C-0.25 X90° improved visual acuity to 6/6. Intraocular pressure was 15 mmHg in the right eye and 14 mmHg in the left eye. Anterior segment examination was unremarkable in both eyes. Hirschberg testing showed 15° of exotropia (Figure 1), and the cover test revealed alternate exotropia. Prism Cover Test (PCT) demonstrated 50 prism diopters (PD) base-in (BI) for upgaze, 35 PD BI at distance and near in primary position, and 25 PD BI in downgaze. The Worth four-dot test indicated right eye suppression at both distance and near.

Figure 1. The Hirschberg test showed 15° exotropia. (Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)



Extraocular movements in both eyes were within normal limits, with no evidence of inferior oblique muscle

overaction (Figure 2). Laboratory findings including complete blood count, renal and liver function tests, serum electrolytes, and blood glucose levels, were within normal limits.

Figure 2. Extraocular movements in both the right and left eyes were within normal limits, with no inferior oblique muscle overaction.



(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

Based on the clinical findings, a diagnosis of V-pattern exotropia without inferior oblique overaction and anisometropic amblyopia of the right eye was established. Given the magnitude of the V-pattern and the absence of significant oblique muscle dysfunction, which showed 50 PD BI for upgaze, 35 PD BI for distance and near, and 25 PD BI for downgaze from Krinsky and PCT. This finding was significant, as a difference in horizontal deviation between two gaze directions of ≥ 15 PD is indicative of a pattern strabismus, vertical transposition of the horizontal rectus muscles was considered. Before surgery, the patient was counseled on the expected outcomes, and written informed consent was obtained.

A right-eye lateral rectus recession of 7-mm combined with medial rectus resection of 5.5 mm was performed. The first stage involved performing the lateral rectus recession in the right eye. The lateral rectus muscle was identified, and a blunt dissection was carried out. A 7-mm recession of the lateral rectus muscle was performed. The lateral rectus tendon width was measured at 8 mm, and a 4-mm mark, corresponding to half the tendon width, was made superiorly from the intended insertion site. Vertical-horizontal muscle transposition (MALE procedure) was applied, with half of the lateral rectus muscle tendon transposed superiorly (Figure 3).

Figure 3. A 7 mm right-eye lateral rectus muscle recession with vertical-horizontal muscle transposition (MALE procedure), involving half of the lateral rectus muscle tendon.

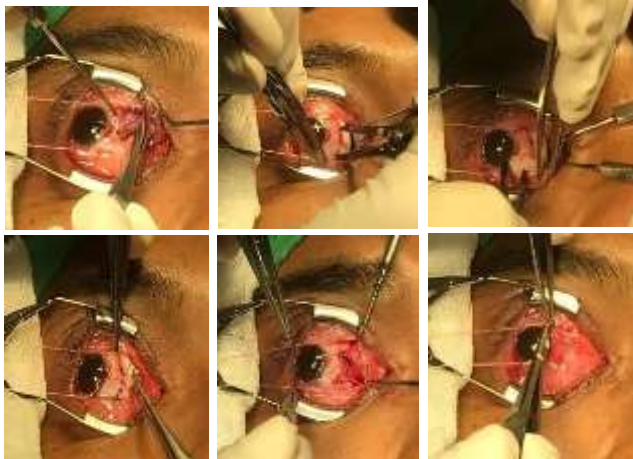


(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

The second stage involved the medial rectus muscle resection in the right eye with a 5.5-mm medial rectus resection

was performed. The medial rectus tendon width was also measured at 8 mm. A 4-mm mark corresponding to half the tendon width was made inferiorly from the insertion site. This procedure also utilized the vertical-horizontal transposition according to the MALE procedure, with half of the lateral rectus tendon width transposed superiorly and half of the medial rectus tendon width transposed inferiorly to address the apex of the V-pattern (Figure 4).

Figure 4. A 5.5-mm medial rectus muscle resection was performed in the right eye, combined with vertical-horizontal muscle transposition (MALE procedure) involving half of the lateral rectus muscle tendon.



(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

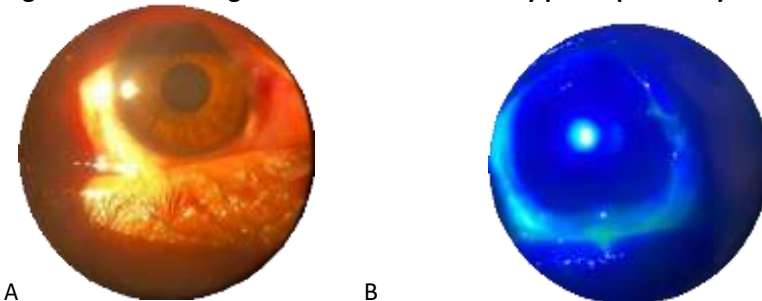
On postoperative day one, ocular alignment demonstrated orthophoria in all positions of gaze (Figure 5). Anterior segment examination showed subconjunctival hemorrhage in the superior and inferior regions of the right eye, without clinical evidence of anterior segment ischemia (Figure 6). Posterior segment evaluation revealed a normal fundus.

Figure 5. Hirschberg test showed orthophoria in all gazes one day post-operatively.



(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

Figure 6. Anterior segment examination one day post-operatively.



(A) Right eye anterior segment examination one day post-operatively.
(B) Right eye fluorescein test one day post-operatively was negative.

(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

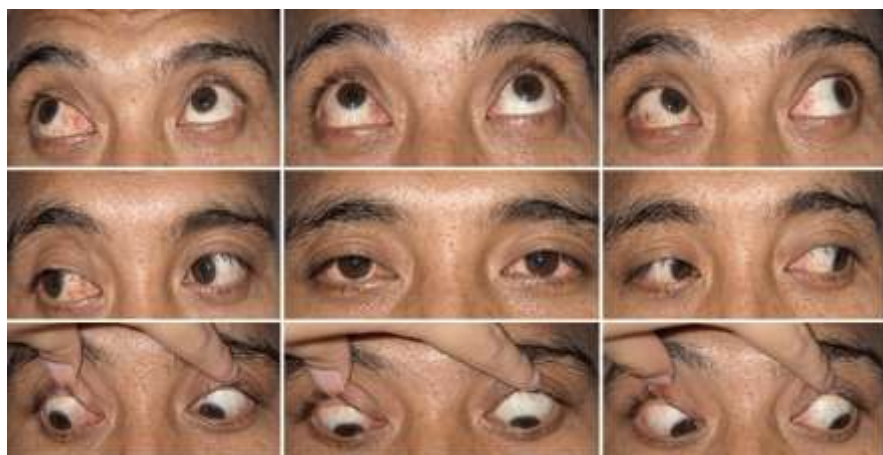
One month postoperatively, examination showed that the visual acuity in the right eye was 6/120 with correction of S -7.00 C -0.50 $\times$ 40°, improving to 6/9.5 without improvement with pinhole testing. Visual acuity in the left eye was 6/12 with correction of S -0.75 C -0.25 $\times$ 90°, improving to 6/6. Anterior segment examination was unremarkable in both eyes. Hirschberg testing demonstrated orthophoria in all positions of gaze (Figure 7). Extraocular motility remained full bilaterally, with no residual pattern deviation or clinically evident ocular torsion (Figure 8). Extraocular movements in both eyes were within normal limits, with no signs of residual pattern deviation or torsion (Figure 8).

Figure 7. The Hirschberg test performed one month postoperatively showed orthophoria, with no measurable deviation in prism diopters.



(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

Figure 8. Extraocular movements were normal in both eyes one month postoperatively.



(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

At 6 months postoperatively, visual acuity remained stable in both eyes. Anterior segment examination was unremarkable bilaterally. Extraocular motility was full, with no limitation or abnormal muscle overaction. Hirschberg testing demonstrated stable orthophoria (Figure 9).

Figure 9. Hirschberg test six month postoperatively showed orthophoria without any prism dioptre misalignment.



(Image obtained with patient consent. Courtesy of Poli Mata, RSUD Dr. Soetomo)

III. Discussion

This case highlights a half-tendon width vertical transposition in monocular surgery is a promising approach for treating large V-pattern exotropia. V-pattern strabismus is characterized by a change in horizontal deviation between upgaze and downgaze. A difference of ≥ 15 prism diopters (PD) is generally considered clinically significant. In this case, the deviation measured 50 PD in upgaze, 35 PD in the primary position, and 25 PD in downgaze, resulting in a 25-PD difference and indicating a large V-pattern exotropia. Importantly, there was no inferior oblique overaction (IOOA) or limitation of extraocular motility.^{1,2,8}

The etiology of V-pattern strabismus is multifactorial and may involve abnormalities of the oblique muscles, horizontal and vertical recti, orbital pulleys, ocular torsion, or supranuclear control. In the absence of significant oblique muscle overaction, vertical transposition of the horizontal rectus muscles is an established surgical option.^{1,5,9,10-14}

Exotropia is a surgical problem. Many options are advocated for the correction of exotropia: unilateral recession-resection, bilateral lateral rectus recession, or bimedial resection. A three- or four-muscle surgery may be necessary for large-angle exotropia. In patients with pattern strabismus, surgery is typically recommended.^{15,16}

Numerous studies have investigated patterns of strabismus, and a variety of surgical procedures have been employed over the years for their correction. Conventionally, in the absence of oblique overaction, the most popular surgical modalities to treat pattern strabismus include weakening of the oblique muscles and vertical transpositions of the horizontal muscles. The combination of vertical transposition and application of the horizontal recti is a novel technique used for the correction of cases with both vertical and horizontal strabismus. The horizontal recti are displaced, with the medial rectus towards the apex of the pattern and the lateral rectus away. Monocular surgery with vertical displacement of the horizontal recti was studied by Metz and Schwartz, who showed satisfactory results with no subsequent torsional symptoms.^{1,11,17-19}

In the absence of oblique overaction, the horizontal recti are displaced, with the medial rectus moving towards the apex of the pattern and the lateral rectus moving away. The MALE (medial rectus muscle to the apex, lateral rectus muscle to the empty space) principle involves moving the medial rectus toward the apex of the pattern and the lateral rectus toward the open end. For a V pattern, this corresponds to inferior transposition of the medial rectus and superior transposition of the lateral rectus. This alters the effective muscle force according to the position of gaze and reduces the incomitance between upgaze and downgaze.^{15,20-23}

The extent of transposition can range from one-half to a full tendon width. Previous studies have reported that half-tendon-width transposition can reduce a V-pattern by approximately 14-15 PD, whereas full-tendon-width transposition may provide greater pattern collapse for 25 PD and is generally considered for larger deviations.^{11,22,24,25,26,28} However, full-tendon-width transposition may produce greater torsional effects, particularly when combined with monocular horizontal muscle offsets.²⁵ Therefore, the optimal amount of transposition should be individualized according to the magnitude of the pattern, ocular motility findings, and binocular function.^{13,14}

In the present case, despite the large 25-PD V pattern, we performed half-tendon-width vertical transposition of the horizontal recti combined with unilateral recession-resection surgery. The lateral rectus was recessed and transposed superiorly, while the medial rectus was resected and transposed inferiorly according to the MALE procedure. This approach was selected because the patient had no IOOA and had reduced visual function in the operated eye.^{11,14, 22,24-26,28}

In this case, a vertical transposition with a half tendon-width LR recession and MR resection was performed. This decision was based on Awadein's study, which showed that LR recession combined with upward transposition provided better correction for V-pattern exotropia (XT). This technique alters the scleral attachment relative to the rotation center of the globe, increasing the arc of contact of the transposed muscle in downgaze and decreasing it in upgaze, thereby reducing the exodeviation more effectively in this direction.²⁴ The procedure to be performed monocularly while avoiding surgery on the better-seeing eye. Monocular V-pattern horizontal muscle offsets can cause significant torsional changes, so they should only be performed on amblyopic eyes in patients with poor binocular fusion to avoid inducing torsional diplopia. This approach allows monocular horizontal offsets to correct torsional diplopia.²⁵

Following surgery, the patient achieved orthophoria in all positions of gaze, with full extraocular motility and no clinically evident torsional abnormality. Alignment remained stable at 6 months postoperatively. This case demonstrates that half-tendon-width vertical transposition of the horizontal rectus muscles, combined with appropriate horizontal muscle surgery, may provide satisfactory correction of a large V-pattern exotropia in selected patients without inferior oblique overaction.

IV. Conclusion

V-pattern exotropia is characterized by greater divergence in upgaze than in downgaze and may be associated with inferior oblique overaction. In the absence of significant oblique muscle overaction, vertical transposition of the horizontal rectus muscles using the MALE principle is an effective surgical option. Although full-tendon-width transposition may provide greater correction for larger patterns, our case demonstrates that half-tendon-width transposition can achieve satisfactory alignment even in a large V-pattern exotropia. In this patient, unilateral half-tendon-

width transposition combined with horizontal rectus recession-resection resulted in orthophoria in all positions of gaze and stable alignment at 6 months postoperatively. This case suggests that half-tendon-width vertical transposition may be a useful surgical option for selected patients with large V-pattern exotropia, particularly when monocular surgery is preferred to avoid operating on the better-seeing eye.

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