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BRIEF CASE REPORT



Single Muscle Transposition in the Management of Monocular Elevation Deficiency

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ABSTRACT

Monocular elevation deficiency is characterized by the inability to elevate one eye in abduction, adduction, and primary gaze. To date, various operations, including Knapp's procedure, have been used in the management of hypotropia associated with this condition. However, single muscle transposition has only recently been described as a feasible alternative, offering a number of advantages over other techniques. In particular, it reduces the risk of anterior segment ischemia and allows for an inferior rectus recession to occur simultaneously as is often required, thus avoiding the need for staged operations. It also facilitates a wider range of management options to correct for associated horizontal deviation. We present a case detailing the use of single muscle transposition in the management of monocular elevation deficiency and in doing so confirm the utility of this novel technique.

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Monocular elevation deficiency; strabismus; amblyopia; hypotropia

Monocular elevation deficiency (MED) is an ocular motility disorder characterized by the inability to elevate one eye in abduction, adduction, and primary gaze.¹ The condition can result from elevator paresis (supranuclear or infranuclear), inferior rectus (IR) restriction, or both, with subtypes being differentiated according to the results of forced duction test (FDT), force generation test, elevation saccadic velocity, Bell's phenomenon, and orbital imaging.^{2,3}

First described in 1969, Knapp's procedure involves the transposition of the horizontal recti to the superior rectus (SR) and is indicated for the management of patients with a negative FDT.⁴ However, due to the association between MED and IR restriction,^{5–7} IR recession is the procedure of choice where FDT is positive. This may at times be performed in combination with Knapp's procedure⁵ or recession of the contralateral SR.⁸ Furthermore, an augmented Knapp's procedure, which combines Knapp's procedure with the use of posterior fixation sutures on the horizontal recti, may also be used in cases where FDT is positive.⁹ Importantly, the IR recession is limited by the tendency to induce consecutive hypertropia in downgaze when the muscle is recessed more than 5 mm.^{8,10} This is particularly problematic for patients with stereopsis, who have the potential to develop diplopia.

We present a case detailing the use of single muscle transposition using the lateral rectus (LR), in combination

with IR recession, in the management of MED, confirming the utility of this novel surgical technique.

A 13-year-old male was referred for assessment of his left hypotropia and ptosis, which he found cosmetically concerning. The hypotropia had been present since birth and he reported no other symptoms. The patient's past medical history of significance was a congenital solitary kidney. There was no family history of strabismus.

On examination, visual acuity was 6/6 bilaterally. Cover testing revealed a 35 prism diopter (PD) left hypotropia for near and distance. In downgaze, he was orthotropic and was able to achieve stereo acuity of 600 sec on Lang testing. There was no abnormal head posture present. Ocular motility was normal in the right eye. In the left eye, there was a -2 deficit of elevation (*Figure 1a*). In primary gaze, the right and left interpupillary apertures were 10 and 7 mm, respectively. The fundi appeared healthy bilaterally. Magnetic resonance imaging (MRI) of the brain and orbits demonstrated smaller left SR compared to the right but was otherwise normal (*Figure 2*).

The patient was diagnosed with left MED and consented for left strabismus surgery. The patient's parents did not give consent for surgery on the right eye. Under general anesthesia, FDT revealed a tight left IR. Despite

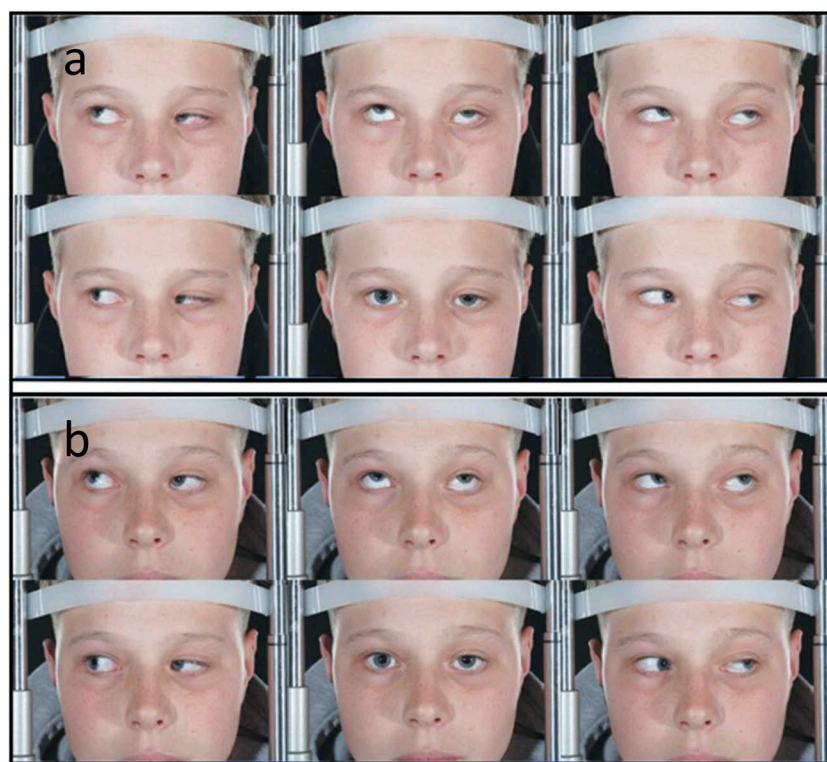


Figure 1. (A) Preoperative photos demonstrating a left hypotropia in primary gaze with -2 deficit of elevation in primary gaze, abduction, and adduction. (B) Postoperative photos demonstrating correction of hypotropia in primary gaze with -1 deficit of elevation in primary gaze, abduction, and adduction and left ptosis.

the finding of a small SR on MRI, the insertions and appearances of all recti muscles were found to be normal intraoperatively. Due to the identification of a tight left IR, the left IR was recessed 5 mm (5-0 Mersilene, Ethicon, New Jersey) and the left LR transposed to the lateral border of the SR (6-0 Vicryl, Ethicon, New Jersey), with an augmentation suture (5-0 Mersilene, Ethicon, New Jersey) placed 8 mm from the insertion between the SR and LR without scleral fixation.

At 4 months postoperatively, the patient's vision remained 6/6 bilaterally. In primary gaze, there was a left hypotropia measuring 3 PD, increasing to 8 PD on up-gaze. On downgaze, a left hypertropia measuring 4 PD was present. The elevation of the left eye had improved to -1 , and there was a mild improvement of the ptosis. He is awaiting surgical correction of his ptosis (Figure 1b).

There is some discordance between the sensory and motor findings and the course.

The authors do not know if the patient had an abnormal head posture during childhood and evidence, such as childhood photos, was not obtained. As such, the patient may have had an abnormal head posture which was lost due to suppression. An alternative possibility is that an abnormal head posture was never present but that the patient was an alternate fixator.

This would have preserved normal acuity development and allowed suppression to develop sufficiently to prevent diplopia. The patient's postoperative sensory status in downgaze was not measured.

The use of single muscle transposition in the management of MED syndrome was first described by Gandhi and Kekkunnaya in 2018¹¹ and is inspired by the utility of SR only transposition (SRT) used for Duane's and sixth nerve palsies.¹² This novel technique overcomes a number of limitations inherent to Knapp's procedure. Anterior segment ischemia is a rare but potentially sight-threatening complication of strabismus surgery caused by disruption to the anterior ciliary arteries. Operations involving three or more recti muscles are at high risk for anterior segment ischemia, and procedures involving three muscles should be avoided or staged.¹³ Not only does single muscle transposition reduce the risk of anterior segment ischemia overall, it allows for IR recession to be performed during the same procedure as horizontal muscle transposition. By operating on the LR only, compared to both horizontal recti muscles, a broader range of management options are also available for correcting any associated horizontal deviation.

Gandhi and Kekkunnaya's original description of single muscle transposition details that the techniques use in five patients with a mean age of 12.4 years.¹¹ Intraoperatively,

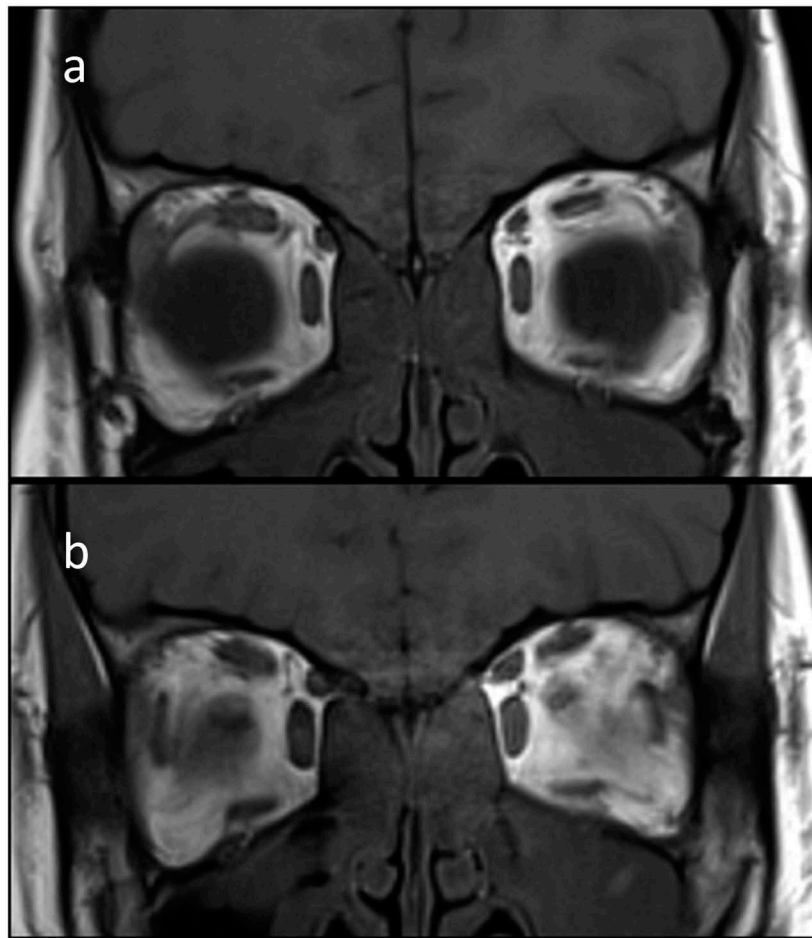


Figure 2. T1-weighted magnetic resonance imaging of the (A) anterior and (B) posterior orbits demonstrating a smaller left superior rectus muscle.

all patients demonstrated a tight IR, with four patients subsequently undergoing LR transposition and one undergoing medial rectus transposition, in addition to IR recession in all cases. The procedures were completed using the same suture technique as was used in our patient. The mean follow-up time was 2 months, and the hypertropia improved from a mean of 35 PD (range, 20–48) to 2 PD. Similarly, the mean elevation deficit decreased from 3.2 to 2 in primary gaze, and the mean depression deficit was 0.5. Jayakumar *et al.* also described a case involving a 21-year-old female with 25 PD of hypotropia, managed with IR recession and LR transposition, again utilizing the same suture technique as our patient.² Their patient was left orthotropic with –1 residual deficit in elevation, 12 months postoperatively.

Our results, in combination with those of Gandhi and Kekkunnaya¹¹ and Jayakumar *et al.*,² confirm that single muscle augmented transposition of the LR, in combination with IR recession, is a useful technique for correcting hypotropia associated with MED of up to 48 PD. In particular, it reduces the risk of anterior segment ischemia

and allows the use of the medial rectus to correct for any associated horizontal deviation.

Declaration of interest

The authors have no conflicts of interest to declare.

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