

Effectiveness of Various Surgical Procedures for Correction of Monocular Elevation Deficit

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Abstract

Monocular Elevation Deficit (MED) is a frequent cause of hypotropia and is associated with ptosis/pseudoptosis. The primary aim of surgery in these cases is to improve Bell's phenomenon and correct misalignment. Various surgical procedures have been described to correct this defect and the choice of procedure depends upon the numerous associated factors. In this retrospective case series we have analyzed the effect of various surgical procedures used to correct MED.

Keywords: Monocular elevation deficit; Ptosis; Knapp's procedure

Introduction

Monocular Elevation Deficiency (MED) is the limitation of elevation of the affected eye from any position of gaze with normal ductions in all other gazes. MED is a frequent cause of hypotropia and is associated with ptosis/pseudoptosis.

Superior rectus palsy, inferior rectus restriction and supranuclear lesions have been found to be contributory to MED.

The primary aim of strabismus surgery in MED is to correct vertical deviation in primary gaze and to improve elevation. The choice of surgery in MED depends on the findings of FDT of inferior rectus (IR). If FDT for IR is tight then an inferior rectus recession must also be performed in addition to primary surgery. Knapp's procedure is commonly practiced and involves full-tendon transposition of horizontal rectus muscles superiorly [1-3].

A modification of Knapp's procedure has also been described by Kamlesh et al. [4] for patients with monocular elevation deficit along with horizontal deviation, in this procedure the splitting of horizontal recti is performed into two halves superior and inferior, of which the superior half is transposed superiorly for correction of vertical deviation and suitable recession or resection of inferior half was performed for horizontal deviation.

The purpose of this case series was to report the various presentations of MED and to evaluate the results of different surgical procedures.

Research Methodology

The study is a retrospective observational study done in a tertiary eye care center. A retrospective review of the records was done from June 2015 to January 2017. Patients with history of trauma, thyroid ophthalmopathy, patients diagnosed with myasthenia gravis and Brown syndrome were excluded from the study. Forty consecutive patients diagnosed with MED were included in this study. A complete

ophthalmological examination was performed which included visual acuity assessment using Snellen's chart, extraocular movements, slit lamp examination, external eye examination and fundus examination. Amount of ptosis, Bell's phenomenon, tightness of Inferior rectus on forced duction test (FDT) and tug of Superior rectus on active force generation test (AFGT) were noted. Pre and postoperative eye deviation measurements were made by modified Krimsky's.

The upgaze limitation of the patients was assessed clinically, and the results were graded from -1 to -4, as follows: mild limitation=-1; moderate limitation=-2; severe limitation=-3; and no elevation above primary position= -4.

All surgeries were performed by any one of the two authors (SP,PS). The postoperative ocular deviation was measured at the end of 3 months by modified Krimsky's. A satisfactory outcome was defined as an ocular deviation aligned to within 10 prism diopter (PD), in the primary position and improvement of Bell's phenomenon.

Surgeries were performed on the basis of clinical presentation, which varied from presence of only elevation deficit due to tight inferior rectus or superior rectus palsy, to associated horizontal deviations along with elevation deficit and presence of superior oblique overaction.

According to surgeries patients were divided into following subgroups:

Group A: Inferior rectus recession performed in patients with tight inferior rectus in force duction test (Figures 1 and 2).

Group B: Vertical transposition of horizontal recti; Knapp's procedure performed in patients with superior rectus palsy and negative force duction test (Figures 3 and 4).

Group C: Knapp's with foster suture; Augmented Knapp's performed in patients with vertical deviation of more than 20 PD.

Group D: In patients with horizontal deviation associated with elevation deficit and negative force duction test, only horizontal muscle resection with Knapp's was done.

Group E: Knapp's procedure performed with posterior tenectomy of superior oblique in patients with monocular elevation deficit with superior oblique overaction.



Figure 1: Pre-operative pictures of a patient with Type 1 MED (Tight Inferior Rectus).



Figure 2: Post op day 1 of the patient of Figure 1, underwent inferior rectus recession.



Figure 3: Pre-operative pictures of a patient with Type 2 MED (Superior Rectus Palsy).

Results

Forty one patients diagnosed with monocular elevation deficit and who underwent strabismus for the correction of hypotropia was included.

Of 41 patients included in the study 25 were males and 16 were females. The median age of presentation was 16 years (range 4 to 30 years). True ptosis was present in 36 of 41 patients, 5 patients had pseudoptosis, Marcus Gunn Jaw Winking phenomenon (MGJWP) was present in 26 patients (Table 1).



Figure 4: Post op picture of patient of Figure 3 who underwent Knapps procedure

Features	Average
Mean age of presentation	16years
Ptosis	36/41
Pseudoptosis	May-41
MGJWP	26/41
Mean Preoperative Deviation (PD)	32.1 pd
Mean Post-operative Deviation	6.2 pd

Table 1: Clinical features.

Thirty five out of forty one patients had only vertical deviation; horizontal deviation along with elevation deficit was present in 6 patients. Mean preoperative vertical deviation was 32.1 PD and mean post-operative deviation was 6.25 PD, thus causing a mean correction of 26 PD and a total success rate of 82.6%. Bells phenomenon improved in all patients, Bells was fair in 31 patients, poor in 5 patients and good in only 5 patients. Individual group results have been summarized in Tables 2, 3, 4, 5 and 6. A comparative evaluation of all the procedures has been summarized in Table 7.

Discussion

In our study right eye was involved in 34/40 patients, similar findings have also been reported by Ziffer et al. [1].

Knapp [2] for the first time described surgical treatment for double elevator palsy and studied 15 patients in a duration of 8 years. The procedure showed marked variability correcting 21-55 PD (average 38 PD) hypotropia. Postoperatively rotations were full in eight cases and mildly restricted in seven. In our case series Knapp's procedure was performed in 13 patients with average preoperative deviation being 31 PD which improved to 6 PD.

Burke et al. [3] studied the effectiveness and long-term stability of Knapp's procedure and found that eight patients were corrected to within 5 prism dioptres of orthophoria, six were undercorrected, and five were overcorrected by at least 5 prism dioptres after a mean follow-up of 3 years (to last visit or to further surgical intervention). The average vertical correction reported in this study was 21.1 PD.

The coexisting horizontal deviation in case of MED is corrected with appropriate recession-resection of the horizontal muscles along

with transposition. Modified Knapp's has been described, where in half belly of the horizontal muscles is transposed while the other half is used for correction of horizontal deviation [4]. Some surgeons may prefer to operate upon the other eye for the horizontal correction. In our case series we had 6 patients with co-existing horizontal deviation. However in these cases rather than combining recession–resection surgery, we performed only the resection of the appropriate muscle, if the amount of deviation was within 30PD. We believe that transposition of a weak (recessed muscle) may weaken the transposition effect and thus will dilute the overall effect of Knapp's procedure. In present series the average horizontal deviation improvement being 32 PD and vertical deviation improvement being 25 PD in post-operative period with the above modification.

S. no	Limitation in upgaze		Pre-operative vertical deviation (PD)	Post-operative deviation in (PD)
	Pre-op	Post-op		
1	-3	-1	18	2
2	-3	-1	20	2
3	-3	-1	16	4
4	-3	-1	20	2
5	-3	-1	20	4
6	-2	–	18	2
7	-3	-1	18	2
8	-3	-1	20	4
9	-3	-1	25	6
10	-3	-1	25	6

Table 2: Surgical results of patients undergoing inferior rectus recession.

S. no	Limitation in upgaze		Pre-operative deviation (PD)	Post-operative deviation (PD)
	Pre-op	Post-op		
1	-4	-1	30	6
2	-4	-1	25	4
3	-4	-1	25	4
4	-4	-1	30	4
5	-3	-1	40	8
6	-3	-1	35	6
7	-4	-1	35	10
8	-3	-1	25	6
9	-4	-1	30	6

10	-3	-1	30	4
11	-4	-1	25	4
12	-4	-1	30	4
13	-3	-1	40	10

Table 3: Surgical results of patients undergoing Knapp's procedure.

S. no	Limitation in upgaze		Pre-operative vertical deviation (PD)	Post-operative deviation in (PD)
	Pre-op	Post op		
1	-4	-1	45	10
2	-4	-1	45	8
3	-4	-1	50	10
4	-4	-1	50	10
5	-4	-1	60	12
6	-3	-1	45	10
7	-4	-1	60	14
8	-4	-1	45	8
9	-3	-1	40	4
10	-3	-1	40	4

Table 4: Surgical results of patients undergoing Augmented Knapp's procedure.

S. no	Limitation in upgaze		Pre-operative deviation (PD)	Post-operative deviation (PD)
	Pre-op	Post-op		
1	-3	-1	30	6
2	-3	-1	30	4

Table 5: Surgical results of patients undergoing Knapp's procedure with posterior tenectomy of superior oblique.

Bandyopadhyay et al. [5] did a retrospective interventional study in 28 eyes of 28 patients with Monocular elevation deficiency (MED), twenty-eight patients were included in this study. Five patients underwent Knapp's procedure, with or without horizontal squint surgery, 17 patients had inferior rectus recession, with or without horizontal squint surgery, three patients had combined inferior rectus recession and Knapp procedure and three patients had inferior rectus recession combined with contralateral superior rectus or inferior oblique surgery, the choice of surgery was based on the results of FDT.

They found, twenty-four of 28 patients (86%) were aligned to within 10 prism diopters. Elevation improved in 10 patients (36%) from no elevation above primary position (-4) to only slight limitation of

elevation (-1). Five patients had preoperative binocular vision and none gained it postoperatively.

In our study of 13 patients, undergoing Knapp's procedure 80.6% were aligned within 10 pd, 10 patients undergoing inferior rectus recession 86.5% were aligned within 10 pd and 81.25% patients undergoing augmented Knapp's were aligned within 10 pd.

S. no	Limitation in upgaze		Pre-operative deviation (PD)		Post-operative deviation (PD)	
	Pre-op	Post-op	Horizontal	Vertical	Horizontal	Vertical
1	-4	-1	30 BI	20	4 BI	2
2	-3	-1	30 BI	25	4 BI	2
3	-3	-1	40 BI	20	12 BI	2
4	-4	-1	70 BI	40	20 BI	8
5	-4	-1	60 BO	40	20 BO	10
6	-3	-1	60 BI	40	30 BI	10

Table 6: Surgical results of patients undergoing Knapp's procedure with horizontal muscle resection.

Surgery	Average preoperative deviations in PD	Average postoperative deviations in PD	Average correction	Success percentage
Inferior rectus recession (n=10)	18.5	2.5	16	86.5%
Knapp's procedure (n=13)	31	6	25	80.6%
Augmented Knapp's (n=10)	48	9	39	81.25%
Knapp's with horizontal muscle resection (n=6)	Horizontal deviation= 48.3 Vertical deviation= 30.8	Horizontal deviation= 16 Vertical deviation=5.6	Horizontal deviation= 32.3 Vertical deviation=25.2	Horizontal deviation=50% Vertical deviation=81.8 %
Knapp's procedure with posterior tenectomy of superior oblique (n=2)	30	5	25	83.3%

Table 7: Summary of preoperative and postoperative deviations and average correction in each group.

IR recession was performed to a maximum of 5 mm, to lower the complications of hypertropia in downgaze and lower lid retraction [6].

Bandyopadhyay et al. reports average correction following inferior rectus recession being 16 PD from an average preoperative deviation of 25.8 PD [5].

Snir et al. [7] compared Knapp's procedure with Augmented Knapp's procedure (conventional Knapp's with posterior fixation sutures on the horizontal recti) in 14 patients of MED. Mean distance and near deviations decreased by 84% and 83%, respectively in the augmented Knapp's group.

In our study Augmented Knapp's procedure (conventional Knapp's with posterior fixation sutures on the horizontal recti) was performed in 10 patients with average correction of 39 PD in post-operative period, mean deviations decreased by 80.6% in patients undergoing Knapp's and 81.25% in patients undergoing Augmented Knapp's.

In our case series 2 patients underwent Knapp's procedure with posterior tenectomy of superior oblique due to associated superior oblique overaction, the results of this procedure has not been reported previously in any other study and both cases had good results in the post-operative period.

Conclusion

To conclude, the patients of MED may present with varying degree of deviation and associated orthoptic manifestations. The management should be tailored according to the clinical manifestations and the selection of correct surgical technique is important for achieving successful alignment.

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