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Strabismus Surgery in Patients With Ocular Neuromyotonia: Potential Unmasking of the Condition and Effective Management Tool

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Abstract

Background—Ocular neuromyotonia is a rare motility disorder in which paroxysms of tonic extraocular muscle contraction from abnormal ocular motor nerve firing result in episodic diplopia and strabismus. Medical therapy with membrane-stabilizing agents has varied success. A surgical approach to treatment has not yet been described. We report the outcomes of strabismus surgery in patients with ocular neuromyotonia.

Methods—We describe three patients with sixth nerve paresis and ocular neuromyotonia of the affected lateral rectus muscle who underwent strabismus surgery. All patients had a history of radiation therapy for intracranial tumors. Ophthalmologic and orthoptic examinations were performed with appropriate medical and neuroradiologic evaluation. Pre-operative and post-operative data are presented and analyzed.

Results—Two patients were noted to have ocular neuromyotonia after their first strabismus surgery for a sixth nerve palsy. Patients 1 and 2 had three surgeries while patient 3 had one operation. Extraocular muscles operated on included the medial rectus and lateral rectus. Pre-operative primary gaze baseline esotropia ranged from 35 to 75 prism diopters (). All patients achieved improvement in ocular alignment and motility. Post-operative primary gaze deviations ranged from orthotropia to 20 of esotropia. Abduction deficits were unchanged or improved. The follow-up period ranged from 15 months to 2 years.

Conclusions—Patients with ocular neuromyotonia of a paretic rectus muscle can achieve binocular fusion with strabismus surgery. Ocular neuromyotonia may manifest post-operatively in patients with a sixth nerve palsy and a contractured medial rectus who, pre-operatively, were not noted to have ocular neuromyotonia.

Keywords

Ocular neuromyotonia; abducens palsy; strabismus surgery; esotropia

Ocular neuromyotonia (ONM) is a rare motility disorder characterized by episodic diplopia and strabismus due to involuntary, tonic extraocular muscle contraction and delayed

relaxation from brief repetitive firing of an ocular motor nerve. The paroxysms may occur spontaneously or be triggered by sustained gaze in the direction of the affected muscle (1). Treatment with membrane-stabilizing agents such as carbamazepine and gabapentin is frequently limited by pharmacological intolerance, recurrence upon discontinuation or a failed therapeutic response (2, 3). Spontaneous resolution of ONM is uncommon (3-7). Surgical correction of an underlying deviation is challenging because the ocular alignment can vary at baseline and between the spasmodic and relaxation phases. In addition, the effect of strengthening or weakening procedures on an extraocular muscle with neuromyotonia is not predictable. We report the outcomes in patients who underwent strabismus surgery for esotropia secondary to sixth nerve paresis with abducens neuromyotonia.

Methods

A retrospective medical record review was conducted on all patients diagnosed with ocular neuromyotonia of the lateral rectus muscle who underwent strabismus surgery at the Stein Eye Institute between 2009-2014. All patients underwent a complete ophthalmologic examination and were diagnosed with ocular neuromyotonia during the strabismus evaluation. Diagnosis was based on a clinical finding of lateral rectus muscle spasm triggered by sustained gaze and causing restriction to adduction, in addition to medical history identifying known risk factors, such as cranial irradiation. There were no exclusion criteria. The study was approved by the University of California – Los Angeles Institutional Review Board and adhered to the tenets of the Declaration of Helsinki.

The following pre-operative and post-operative characteristics were recorded from the patients' charts: age at surgery, best corrected visual acuity, pre-operative motor alignment at distance and near and in the cardinal positions of gaze, and an assessment of ocular ductions. Ocular ductions were measured using a standard 4-point scale. Forced duction testing was performed intra-operatively and graded on a scale of 0 to -4 (8). In addition, details of the surgical procedure, adjustment amount (if required), and post-operative ocular alignment and ductions were recorded. Any post-operative complications were recorded.

Results

Characteristics of 3 patients with ocular neuromyotonia who underwent strabismus surgery are summarized in Table 1. All patients had a history of intracranial tumors treated by resection and irradiation and demonstrated abducens neuromyotonia in the setting of a sixth nerve paresis. The mean delay in onset of neuromyotonia post-radiation was 10.3 years (range: 6-13 years). Medical management failed to control the spasms in all patients. Patients 1 and 2 had three surgeries. Patient 3 underwent one operation. In two cases, the ocular neuromyotonia was diagnosed following strabismus surgery. In both of these cases, forced duction testing revealed restriction to abduction intra-operatively. All patients underwent recession of the ipsilateral medial rectus in combination with a strengthening procedure of the affected lateral rectus muscle. Two patients underwent bilateral surgery. Primary gaze deviations ranged from 35 to 75 prism diopters (). All patients achieved improvement in ocular alignment and motility. Post-operative primary gaze deviations

ranged from orthotropia to 20° of esotropia. Lateral incomitance was reduced in all patients. The follow-up period ranged from 15 months to 2 years.

Case Reports

Patient 1

A 44-year-old woman underwent three surgeries for removal of a pituitary adenoma with extension into the left cavernous sinus followed by stereotactic radiosurgery. Six months later, she developed diplopia due to a right sixth nerve palsy. Positron emission tomography (PET) showed no evidence of tumor recurrence but FLAIR and T2 MRI demonstrated evidence of radiation necrosis in the medial aspect of both temporal lobes.

Seven months after onset of diplopia, the patient was documented to have an esotropia of 35 PD. She underwent a 7.5 mm right lateral rectus resection and a 5.0 mm left medial rectus recession. This resulted in an under-correction so a second surgery was performed consisting of 7.0 mm left lateral rectus resection and a 4.0 mm right medial rectus recession.

Five years later, the patient returned with complaints of horizontal diplopia at distance and near which had been progressively worsening over a two-year period. She had an esotropia of 18° in central and right gaze and was orthotropic in left gaze. Ocular rotations showed mild limitation to abduction bilaterally. After sustained lateral gaze to either side, the patient developed a large angle exotropia with significant limitation to adduction in the abducted eye (−2 to −3). Her presentation was consistent with bilateral abducens ocular neuromyotonia with bilateral sixth nerve palsies. Serologic testing for myasthenia gravis and Graves disease was negative and neuroimaging showed no evidence of tumor recurrence. Treatment with carbamazepine failed to resolve her symptoms. She elected to undergo strabismus surgery for her esotropia. Intra-operative forced duction testing was positive in abduction (−1) bilaterally. Both medial rectus muscles were recessed from 12 mm to 15 mm posterior to the limbus. Post-operative, the patient was orthotropic in central gaze and had a 4° exophoria in left gaze and a 4° esophoria in right gaze. Prolonged eccentric gaze did not elicit neuromyotonia. Over 2 years, ocular motility and alignment here remained stable.

Patient 2

A 56-year-old woman with a 12 year history of diplopia due to nasopharyngeal carcinoma had undergone craniotomy, chemotherapy and radiotherapy. On examination alignment was highly variable. The largest amount of esotropia measured 75° at distance and 85° at near. There were also times she was completely orthotropic or even slightly exotropic. Ocular rotations demonstrated significant limitation to abduction in the right eye and very slow abducting saccades. During sustained right gaze, abduction improved and the esotropia resolved. With return to central gaze there was limited adduction of the right eye but following sustained gaze to the left, the patient regained full adduction.

Treatment with carbamazepine (200 mg twice daily) yielded no improvement in alignment or in reducing the frequency and severity of spasms. During strabismus surgery forced duction testing was normal and both medial rectus muscles were recessed 5.5 mm. Postoperatively, the esotropia measured 14° at distance and 35° at near. It was not clear

why there was a much larger deviation at near, but we speculated it could be due either to innervational imbalance or mild subclinical neuromyotonia of the medial rectus muscles. Initially, the patient reported significant improvement in her ability to control the spasms with longer periods of orthotropia. However, gradually there was an increase in diplopia and, once again, carbamazepine was ineffective. Therefore, both medial recti were recessed to a position 15 mm posterior to the limbus. In addition, a posterior fixation suture on the right lateral rectus muscle at 8 mm from the insertion to reduce the exotropia in lateral gaze. Post-operatively, there was an esotropia of 2 at distance, orthotropia at near and the patient reported single vision most of the time. Ocular neuromyotonia could still be elicited, but the resultant deviation was greatly reduced.

Over the next four months, the patient had an intermittent esotropia that varied from a small phoria to 25 in primary position with lateral incomitance in right gaze. A third surgical procedure involved take down of the posterior fixation suture and a right lateral rectus plication of 3.5 mm. Post-operatively, she was orthotropic in all gaze positions and the abduction deficit improved to full rotation. At 9 months follow-up, ocular alignment and motility remained stable, and the patient noted only rare recurrence of spasms.

Patient 3

A 77-year-old woman with a history of a clival chordoma status-post resection, radiation, and gamma knife treatment 15 years prior was evaluated for a 2-year history of binocular horizontal diplopia. She had 30 of left esotropia and 4 of left hypertropia at distance, 16 of left esotropia and 2 of left hypertropia at near and exhibited a left face turn of 10 degrees. Ocular rotations were full except for limited abduction of the left eye (−2). Maddox rod testing revealed no evidence of ocular torsion and there was no change in eye position following sustained eccentric gaze.

The patient underwent a left medial rectus recession of 5.5 mm with a 2.0 mm inferior transposition and a left lateral rectus plication of 6.0 mm. Intraoperative forced duction testing revealed mild restriction to abduction (−1). Post-operatively, she was orthotropic in all gaze positions except in left lateral gaze where she measured 8 of esotropia. Abduction was improved but not full (−1). Four months after surgery, she returned with complaints of recurrent diplopia. On examination, she demonstrated a greater limitation to abduction of the left eye (−2) and a left esotropia of 20 increasing in left gaze. With sustained left gaze, she developed an exotropia in primary position with significant limitation to adduction of the left eye, consistent with a left abducens ocular neuromyotonia. Carbamazepine did help to reduce the spasms, but was discontinued due to hyponatremia. At 15 months following surgery, her deviation measured 20 of esotropia and the ocular neuromyotonia could no longer be elicited.

Discussion

In our review of the literature, 50% of reported cases of ocular neuromyotonia had ocular misalignment in primary gaze [1-3, 5-36]. There are 4 single case reports of strabismus surgery in patients with ocular neuromyotonia and an additional case series of strabismus surgery in 3 patients with a cyclic vertical deviation that the authors describe as a “forme

fruste ocular neuromyotonia” (3, 6, 7, 30, 36). All seven patients had undergone recession of the neuromyotonic muscle with resolution of paroxysms post-operatively.

These results suggest that weakening the neuromyotonic muscle may ameliorate spasms by reducing the resting tension or the force that the muscle is able to generate. If the converse is true of strengthening procedures, a resection or plication might exacerbate the paroxysms. This presents a dilemma for the surgeon when trying to correct esotropia due to a sixth nerve palsy but the paretic muscle also demonstrates neuromyotonia.

In two of our patients, recession of the medial rectus and resection of the lateral rectus was performed as the initial operation and ocular neuromyotonia did not appear until 4 months and 2 years in patients 3 and 1, respectively. This phenomenon has been reported previously. De Saint Sardos et al (30) described a 15-year-old girl with parasellar metastasis of a medulloblastoma who developed right abducens ocular neuromyotonia 10 months after bilateral medial rectus recessions. Much et al (7) documented a 35-year-old woman who had transphenoidal surgery, external beam radiotherapy and radiosurgery for pituitary tumor with cavernous sinus invasion. She developed exotropia from a left third nerve palsy and underwent left lateral rectus recession and left medial rectus resection. One year later she developed left medial rectus neuromyotonia.

One explanation for this finding is that restriction by a contracted antagonist muscle may have prohibited ocular rotation, masking the spasms pre-operatively. Delayed onset of ocular neuromyotonia is another possibility. Tightening the neuromyotonic muscle, by plication in patient 2, did not alter the spasms. In patient 2, a faden operation on the spastic lateral rectus reduced the amount of deviation during a neuromyotonic episode. When lateral incomitance needs to be addressed, a faden procedure can be performed on either the spastic muscle or the contralateral yoke muscle. Theoretically, this should worsen the spasms due to fixation duress yet, interestingly, this did not occur in our patient.

In planning surgery for patients with neuromyotonia, we believe that surgeon should correct the deviation present in primary position, and not the deviation where the spasm is occurring even if the spasm is occurring frequently. If the forced duction test is positive, surgeons should recess the tight muscle. In our experience, the spasms seem to worsen if a tight antagonist is recessed or if the spasmodic muscle is resected if fixation duress is created. Our approach to these patients includes the use of recess/resect procedure on the paretic eye provided there is lateral rectus function present. For lateral incomitance, surgery on the fellow eye can be considered as either a faden procedure or a standard recess/resect operation. Faden procedures not only potentially diminish the spasms associated with neuromyotonia, but they may reduce lateral incomitance in cases of palsied muscles. It is unclear if plication procedures have a similar effect on neuromyotonia. In case 2, our results were somewhat unexpected after plication. It is possible that enesthetic disruption plays a role in lessening neuromyotonia and, therefore, it may be that plication procedures lead to different results. This possibility deserves further study.

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Table 1

Clinical features of patients with ocular neuromyotonia undergoing strabismus surgery

Case	Diagnosis	Pre-operative Neuro-myotonic LR	Pre-operative Resting Deviation () [*]	Pre-operative Resting rotations	Pre-operative Spasmotic deviation	Pre-operative Spasmotic rotations	Surgeries performed	FDT	Post-operative Alignment and Motility	Follow-up ^{††} (months)
1	BLR paresis (invasive pituitary adenoma)	BLR	ET 18 Ortho, LG ET [†] 12	Limited adduction (–1) ^a OU	Large angle XT	Limited adduction OU (–2)	RMRc 3.0 mm (12 to 15 mm PTL), LMRc 3.0 mm (12 to 15 mm PTL) ^c	–1 to abduction OU	Ortho distance Ortho near Rotations unchanged No OMN elicited/ reported	24
2	BLR paresis (nasopharyngeal carcinoma)	RLR	RET 75 RET [†] 85 RET 45, LG RET 100, RG	Limited abduction (–5) OD	Large angle XT	Limited abduction (–2) and limited adduction (–1) OD	#1: BMRc 5.5 mm #2: BMRc 5.0 mm, RLR faden 8 mm #3: RLR plication	0	Ortho distance Ortho to X(T) [†] 25 Improved abduction (–1) OD Limited adduction (–1) OU Reduced OMN episodes ^d	8.5
3	LLR paresis (clival chordoma)	LLR	LET 30, LHT 4 LET [†] 16, LHT [†] 2	Limited abduction (–3) OS	n/a ^b	n/a ^b	LMRc 5.5 mm with inferior transposition ^c , LLR plication ^c	–1 to abduction OS	LET 12 Ortho near Rotations unchanged Reduced OMN episodes ^{d,e}	8

^{*}Gaze incoherence of 10° noted when present.^{††}Post-operative follow-up from last strabismus surgery^aPrior history of strabismus surgery: left medial rectus recession 5.0 mm and right lateral rectus recession 7.5 mm, right medial rectus recession 4.0 mm on adjustable suture and left lateral rectus resection 7.0 mm^bOMN presented after strabismus surgery^cMuscle placed on an adjustable suture^dReduced frequency and magnitude of ocular deviation^eUpon treatment with carbamazepine

FDT, forced duction test. LG, left gaze. RG, right gaze. PTL, posterior to limbus.