Isolated schwannoma involving extraocular muscles

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BACKGROUND Progressive strabismus initially considered idiopathic may be caused by isolated schwannomas of motor nerves to extraocular muscles, detectable only on careful imaging. This study reviewed clinical experience of a referral practice in identifying schwannomas on magnetic resonance imaging (MRI).

METHODS We reviewed 647 cases imaged for strabismus to identify presumed cranial nerve schwannomas, identified by gadodiamide-enhanced, high-resolution surface coil orbital MRI and thin-section cranial MRI. Clinical features and management were correlated with MRI.

RESULTS Schwannomas were identified as fusiform intraneural enlargements in 8 cases: 1 affecting the trochlear nerve; 2, the abducens nerve; and 5 the oculomotor nerve. Involved muscles were atrophic. Both abducens schwannomas, 1 superior oblique, and 1 oculomotor schwannoma were subarachnoid; 3 were intraorbital, and bilateral oculomotor lesions of 1 case extended from cavernous sinus to orbit. Associated strabismus progressed for 3-17 years. Abducens schwannoma caused esotropia; trochlear schwannoma caused hypertropia and cyclotropia. Intracranial oculomotor schwannoma caused mydriasis and exotropia. Intraorbital schwannoma caused exotropia with or without hypertropia. Since lesion diameters were 3–9 mm, 6 had been previously missed on routine MRI.

CONCLUSIONS Progressive, acquired strabismus may be caused by isolated cranial nerve schwannomas, representing about 1% of strabismus cases in this study, involving the oculomotor more than abducens nerve. Because most schwannomas are small and deep in the orbit, findings could be readily missed by routine imaging, leading to a possible diagnosis of idiopathic strabismus. Schwannomas should be suspected when extraocular muscles are atrophic, but the causative lesions themselves are identifiable only using targeted, high resolution MRI. (J AAPOS 2016;20:343-347)

Progressive acquired strabismus frequently presents a diagnostic dilemma for clinicians. Etiologies such as myasthenia gravis, thyroid orbitopathy, and ischemic cranial neuropathy may be readily diagnosed on clinical grounds by physical examination and specific laboratory tests.[1-3] Other cases of progressive acquired strabismus are often simply categorized as "idiopathic" without efforts for identification of etiology. Improvements in imaging techniques have made it possible for clinicians to diagnose underlying causes in these "idiopathic" cases.[4] Isolated schwannomas (also known as neuromas) of cranial motor nerves are among these underdiagnosed cases.[5] These well-defined, slowly progressive tumors which originate from Schwann cells of peripheral nerves, derange ocular motility in several ways. Typically the clinical course of schwannomas is that of progressive cranial nerve dysfunction or relative stability.[6] However, the clinical picture is seldom as clear as with complete cranial nerve palsy. Partial cranial nerve palsies create atypical strabismus presentations that can be easily misdiagnoed. This study employed targeted high-resolution magnetic resonance imaging (MRI) to provide insight into the imaging and clinical properties in cases of progressive acquired strabismus caused by schwannomas.

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Subjects and Methods

This is retrospective analysis of data collected in an ongoing, prospective study of strabismus that has been conducted continuously since 1990 at the Jules Stein (now the Stein) Eye Institute, UCLA. At time of analysis in late 2015, a total of 647 patients had undergone high-resolution orbital MRI for strabismus. Among these were 36 cases of oculomotor nerve palsy, 95 cases of trochlear nerve palsy, and 32 cases of abducens nerve palsy. A

Table 1. Clinical and imaging findings in patients with schwannoma

Case	Age, years	Sex	Cranial nerve involved	Symptom duration, years	Initial negative imaging	Tumor location	Tumor size, mm	Shape
1	60	M	Medial rectus motor nerve	10	Yes	Deep orbit	2.9 × 3.9	Nodular
2	21	F	Medial rectus motor nerve	1	Yes	Deep orbit	3.3 × 2.8	Nodular
3	6	F	Medial rectus motor nerve	2	Yes	Deep orbit	4.7 × 7.7	Nodular
4	60	M	Oculomotor	20	No	Intracavernous and intraorbital	7.7 × 10 and 2.6 × 7.7	Fusiform
5	55	F	Oculomotor	5	Yes	Subarachnoid at posterior communicating artery	5 × 5	Nodular
6	60	M	Abducens	6	Yes	Subarachnoid	5 × 5	Nodular
7	45	M	Abducens	2	No	Subarachnoid and intracavernous	6 × 12	fusiform
8	50	M	Trochlear	5	Yes	Subarachnoid ambient cistern	5 × 5	Nodular

nonconsecutive subset of these patients who had progressive, acquired cranial neuropathy suspicious for cranial nerve involvement also underwent MRI of the intracranial space. Schwannoma was diagnosed by clinical course and typical radiological properties. Written informed consent was obtained prospectively according to a protocol approved by the UCLA Human Subject Protection Committee, later renamed the UCLA Investigational Review Board 1 for the Protection of Human Subjects, from patients who were recruited from referral strabismus practices. Complete ophthalmologic examination and ocular motility evaluation, including prism cover testing, photography, and Hess screen testing, was performed for appropriate patients.

A 1.5 T General Electric Signa scanner (Milwaukee, WI) was used in orbital imaging, as previously described.[7] Imaging was performed using an array of surface coils embedded in a transparent facemask (Medical Advances, Milwaukee, WI) for improved resolution and another array of individually illuminated fixation targets to avoid eye motion artifacts. The standard head coil was used for imaging at and posterior to the orbital apex in some subjects at 1.5 or 3 T. When surface coils were used, quasi-coronal images perpendicular to the long axis of orbit and quasi-sagittal images parallel to the long axis of the orbit were obtained at 2 mm thickness in a matrix of 256 × 256 over a field view of 6–8 cm for a resolution in plane of 234–312 μm, respectively. Brainstem imaging was performed in 0.8 mm thickness planes using the heavily T2-weighted FIESTA sequence to obtain contrast of cranial nerves against the subarachnoid cerebrospinal fluid. Resolution in the brainstem region was generally 195 μm in a 512 × 512 matrix over a 10 cm field of view with 10 excitations.

Results

A total of 8 cases (3 of which were previously presented in brief reports[7,8]) were identified that represent a spectrum of clinical forms of isolated cranial nerve schwannomas. Their clinical and imaging properties are summarized in Table 1. Clinical summaries are provided for informative cases not previously described.

Oculomotor Schwannomas

The oculomotor nerve was involved in 5 cases. One case had bilateral neuromas extending from the cavernous sinus to the orbit. One case was located in the subarachnoid space, and 3 cases were located entirely in the deep orbit. All cases had unilateral schwannomas except the patient who had bilateral schwannomas (case 4) extending from the cavernous sinus to the orbit.

Intra-orbital Oculomotor Schwannomas

Case 1, with intraorbital neuroma of the medial rectus motor nerve, was a 60-year-old man who had a 10-year history of occasional horizontal, binocular diplopia with progressive right medial rectus paresis. He had 50$^{\Delta}$ right exotropia at distance and 35$^{\Delta}$ at near, with limited adduction and slow adduction saccades of the right eye. Cranial nerves and ocular motility were otherwise normal. Orbital MRI disclosed medial rectus muscle atrophy (Figure 1) and a 2.9 × 3.9 mm contrast-enhancing tumor in the motor nerve to the medial rectus, deep in the orbit and close to the muscle (Figure 2).

In case 2, a 21-year-old woman complaining of diplopia, the schwannoma was located deep in the orbit. She had noticed slowly progressive right exotropia since giving birth 3 years previously. Routine brain MRI was interpreted as normal. Cranial nerves were clinically normal except that the right eye could not adduct more than about 20° to the right of midline, with profound slowing of the adduction saccade. Right exotropia exceeded 100$^{\Delta}$, with 30$^{\Delta}$ right hypertropia. Ophthalmoscopy using a quantitative technique for fundus torsion demonstrated 30° right fundus excycloposition and 25° left excycloposition.[9] Routine MRI revealed no lesion along the subarachnoid oculomotor nerve, no evidence of infarction in the midbrain, or any lesion in apical orbital portion of inferior division of the oculomotor nerve. High-resolution surface coil MRI of the orbits demonstrated profound atrophy of the deep portion of the right medial rectus muscle (Figure 3) and a small enhancing lesion (3.3 × 2.8 mm) in the path of the intraorbital motor nerve to the right medial rectus muscle (Figure 4) compatible with schwannoma. The medial rectus muscle atrophy corresponded to the location of the schwannoma (Figure 3). All other extraocular muscles exhibited normal size, and all extraocular muscles had normal paths.

Clinical details of case 3 have been published previously.[7]