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Spasmus Nutans

A Quantitative Prospective Study

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• Spasmus nutans includes ocular oscillations, head nodding, and anomalous head positions. No quantitative longitudinal study verifying the natural history of this self-limited condition has appeared in the literature. Using infrared oculography, we prospectively examined the eye movements of otherwise neurologically normal infants in whom a diagnosis of spasmus nutans had been made. At this writing the ocular oscillations and head movements in two of the children were clinically absent, thereby confirming the diagnosis. The ocular movements are characterized by a phase difference between the oscillations of each eye that varies both during one recording session and during development. The dissociated, pendular nystagmus consists of high-frequency oscillations that may be disconjugate, conjugate, or purely uniocular.

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Nystagmus in infancy may be due to a variety of disorders. The differential diagnosis includes "idiopathic" congenital nystagmus, latent/manifest latent nystagmus, nystagmus in association with optic nerve glioma, and spasmus nutans. Once optic glioma is excluded, spasmus nutans may be suspected from anomalous head movement and disconjugate oscillations, but, prior to this study, only follow-up would confirm whether a child had congenital nystagmus or spasmus nutans.

Few reports present well-documented recordings of eye movement in infants and children with a diagnosis of spasmus nutans.[1-4] In none of the recorded cases was the diagnosis of spasmus nutans confirmed, since a longitudinal analysis of the nystagmus as well as clinical confirmation were not included in the reports. Previously, one of the essential criteria in documenting spasmus nutans has been the spontaneous resolution of nystagmus and anomalous head positions.

We have prospectively conducted a study of the ocular oscillations in infants with the presumptive diagnosis of spasmus nutans with the objective of identifying pathognomonic features early in its course. A preliminary report of this work was presented at the conference "Adaptive Processes in Visual and Oculomotor Systems."[5]

PATIENTS AND METHODS

The patients included in this study were referred for evaluation of nystagmus. All seven underwent a comprehensive ophthalmologic and neurologic evaluation. None of the patients in the study group showed signs of neurologic deficit, diminished visual acuity, strabismus, optic nerve abnormality, or ocular pathologic disorder.

When possible, the infants and children were videotaped before the oculographic recording session. Movements of both eyes were recorded using infrared or DC electro-oculographic techniques. During the recording session, the patients were seated comfortably in their parents' laps. The investigator steadied the infrared "glasses" in front of the infant's eyes. The total system bandwidth (position and velocity) was 0 to 100 Hz. Although absolute amplitude calibration was not possible, this method allowed accurate measurement of waveforms of ocular oscillations. Since the saccades of the patients were conjugate (judged clinically and by studying the videotapes), adjustment or comparison of the gains of both position channels provided a good measure of the relative amplitudes of the nystagmus in each eye. For most of the recording sessions, eye velocity was also obtained for more accurate delineation of the waveforms. Analysis of the records included an evaluation of the waveform, oscillation frequency, relative waveform amplitude, and phase relationships.

RESULTS

Table 1 summarizes the results of the clinical evaluation. The mean age at onset, based on the mother's account, was 5 months, with a range of birth to 14 months. Five of the seven patients exhibited head nodding or tilting in addition to the ocular oscillations. One of the children seen for a follow-up evaluation demonstrated a resolution of his ocular oscillations ten months after onset, thereby confirming the diagnosis of spasmus nutans. This patient had been observed to have abnormal head movements. Another infant showed no ocular oscillations on the videotaped record although there was occasional head nodding. However, persistence of her nystagmus was evident in the eye-movement records. The patient's mother reported an improvement in this infant's nystagmus and head movement.

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An example of a typical eye-movement recording associated with spasmus nutans is shown in the Figure. The record shows both eyes at three very closely spaced times (within seconds) during a single recording session for one patient (patient 3). The pendular oscillations of both eyes varied from in phase to 180° out of phase within just 2 s. The uniocular portion of the record occurred 90 s before this interval. Uniocular oscillations were observed in five of seven patients.

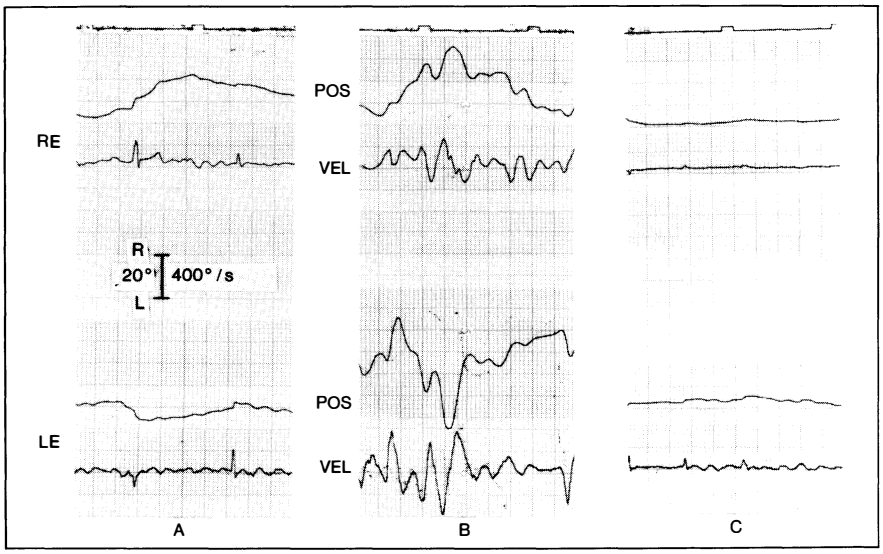
Table 2 summarizes the nystagmus characteristics. All patients demonstrated a pendular waveform both in the initial and follow-up records. The frequency of the ocular oscillations ranged from 3 to 10 Hz. Most patients showed a range of frequencies within one recording session. All of the patients exhibited an asymmetry of the amplitudes of the oscillations in the two eyes. Three showed intervals of asymmetric oscillations and other intervals of symmetric waveform amplitudes during a single recording session. All patients showed variable phase relationships between the oscillations of each eye. Four patients exhibited phase differences ranging between 0° and 180°. In one patient the phase difference variability was in a narrower range, remaining between 120° and 180°. The results of analysis (mean and SD) of approximately ten measured cycles from each record, as shown in Table 2, underscore this variability. One infant, patient 3, at the first recording at 10 months of age showed only in-phase oscillations. However, at a subsequent recording session seven months later the phase relationships between the waveforms in each eye varied from 0° through 180°.

Analysis of the records also included classification into relative conjugacy of the waveforms. The scale used consists of the following: +2, equal amplitude of waveforms between the two eyes and in phase; +1, unequal amplitude and in phase; 0, uniocular oscillations; −1, unequal amplitude and out of phase; and −2, equal amplitude and out of phase. For purposes of this scale, *in phase* means that there was a phase difference of less than 90° between the eyes; *out of phase* means the difference was more than 90°. Six of the seven infants showed variable conjugacy during a single recording session. Although conjugacy varied, most infants showed one particular predominant conjugacy relationship, usually −1 or +1. Two infants exhibited little variability of conjugacy. However, one of these infants showed varying conjugacy at a later recording session.

Table 1.—Clinical Data*

Patient No.	Date of Recording (Type)	Age at Recording	Age at Onset	Age at Disappearance	Head Movement
1	1/20/83 (EOG)	4 mo	2 wk	...	...
	5/19/85 (Infrared)	2.5 y	...	...	Tilt
2	1/4/84 (EOG)	6 mo	2 mo	12 mo (8/84)	None
	5/30/85 (Infrared)	2 y	...	...	...
3	10/22/84 (Infrared)	10 mo	Birth	...	Nod
	6/6/85 (Infrared)	17 mo	...	None on videotape	Occasional nod
	3/25/86 (Infrared)	27 mo	...	...	...
4	2/13/85 (Infrared)	14 mo	14 mo	...	Tilt and nod
5	4/17/85 (Infrared)	6 mo	4 mo	...	Tilt and nod
	10/9/85 (Infrared)	12 mo	...	...	Occasional nod
6	1/10/86 (Infrared)	6 mo	3 mo	...	None
	3/21/86 (Infrared)	8 mo	...	...	...
7	11/8/85 (Infrared)	18 mo	13 mo	...	Nod
	2/18/86 (Infrared)	21 mo	...	...	Occasional nod

*EOG indicates electro-oculography.



Example of nystagmus of spasmus nutans observed in patient 3 with following relative amplitudes: (A) binocular oscillation with no phase difference, (B) binocular oscillation with 180° phase difference, and (C) uniocular oscillation of left eye (LE). RE indicates right eye; POS, position; VEL, velocity; and timing marks represent 1-s intervals.

In one patient, the vestibulo-ocular reflex was stimulated by quasisinusoidal passive movement of the infant's head in the horizontal plane. This manipulation did not suppress his ocular oscillations. Active head movement in relation to the ocular oscillations was not evaluated.

COMMENT

Spasmus nutans is a self-limiting disorder of infancy and early childhood that was first fully described by Raudnitz[6] in 1897. The pathogenesis of this entity remains obscure. Over this period, only four longitudinal studies of the clinical course have been reported, to our knowledge.[7-10] Few quantitative analyses of the ocular oscillations have appeared in the literature.[1,4,11,12] These patients did not have a firm diagnosis of spasmus nutans, as no follow-up was obtained. The present study is the first study to date that both clinically and oculographically evaluates over a substantial period infants with a diagnosis of spasmus nutans. This investigation also provides the first quantitative documentation of eye movement recordings in a patient whose acquired, dissociated, pendular nystagmus subsequently resolved. Spasmus nutans is a condition that should be differentiated from other diseases of infancy that have significant morbidity and potential mortality.

Several reports have described cases in which infants presented with

Table 2.—Characteristics of Spasmus Nutans

Patient No.	Date of Study	Waveform*			
		Frequency, Hz	Relative Amplitude	Phase Relations	Conjugacy
1	1/83	3	R > L; R = L	Range, 0-180; m, 135.5; SD, 52.9	−1 > 0, −2
	5/85	3-5	R > L; R = L	Range, 0-180; m, 78.7; SD, 61	+1 > 0, −1, −2, +2
2	1/84	4-6	R > L; R = L	Range, 0-180; m, 129.7; SD, 73.4	−1, −2 > +1, +2, 0
	5/85†	. . .	. . .	. . . .	. . .
3	10/84	7-9	R > L	Range, 0	+1
	6/85	6-7	L > R	Range, 0-180; m, 89.6; SD, 70.5	+1, −1
	3/86	5-6	L > R	Range, 30-160; m, 112; SD, 54.5	0, +1
4	2/85	6	L > R	Range, 120-180; m, 142.1; SD, 22.2	−1
5	4/85	5-6	L > R	Range, 0-180; m, 104.3; SD, 63.7	−1 > +1
	10/85	9	L > R	Range, 15-180; m, 108.9; SD, 72.4	+1, +2
6	1/86	5-8	R > L	Range, 0-45; m, 9; SD, 18	+1, 0
	3/86	8-10	R > L	Range, 0-90; m, 32.1; SD, 39.6	+1, 0
7	11/85	8-9	L > R	Range, 90-180; m, 166.2; SD, 29.5	0 > −2, +2
	2/86	8-9	L > R	Range, 0-90; m, 36; SD, 33.7	0, +1

*All waveforms were pendular. The conjugacy scale is as follows: +2 indicates equal amplitudes, in phase; +1, unequal amplitudes, in phase; 0, uniocular; −1, unequal amplitudes, out of phase; and −2, equal amplitudes, out of phase. m indicates mean. Amplitudes and conjugacies are listed in order of descending incidence.

†No ocular oscillations were present.

pendular and often asymmetric nystagmus initially diagnosed as spasmus nutans.[13-17] These infants were later found to have optic nerve and intracranial gliomas. An important clinical feature in all of these patients was the presence of optic nerve atrophy. Some of the patients exhibited other associated clinical findings, such as diencephalic syndrome and evidence of increased intracranial pressure. There is also one report of an infant who presented with acquired pendular nystagmus and was initially diagnosed as having spasmus nutans. The subsequent clinical course and autopsy findings confirmed the diagnosis of Leigh's subacute necrotizing encephalomyelopathy.[18]

Congenital nystagmus is a conjugate oscillation that may be first noted during infancy. The diagnostic distinction between congenital nystagmus, latent/manifest latent nystagmus, and spasmus nutans is important. Congenital and latent/manifest latent nystagmus are associated with life-long impairment of visual acuity; the siblings and children of a patient with congenital nystagmus may be similarly affected. Thus, it is important to differentiate congenital nystagmus from spasmus nutans as early as possible.

All of the patients included in our study had normal results of ophthalmologic and neurologic examinations. Although visual acuity was not formally tested, all parents reported a normal ability of the infant to attend to visual tasks such as locating raisins and other small objects without difficulty. All of the patients with acquired pendular nystagmus described by Gresty et al[19] complained of oscillopsia that interfered with their daily activities; it is difficult to determine whether infants with spasmus nutans have this problem. By observation they show no gross impairment in their visual function.

Gresty et al[1,11] described three patients who exhibited a distinct pattern of eye-head coordination. All carried a tentative diagnosis of spasmus nutans; head shaking modified their nystagmus so that vision improved. However, all were older children (more than 3 years of age) and follow-up was not obtained. Suppression of nystagmus occurred with both active and passive head shaking. Gresty et al interpreted this adaptive suppression of nystagmus as due to vestibular stimulation. In one of our patients (patient 3) we passively rotated the infant's head horizontally and observed no modification of the nystagmus. This patient's nystagmus subsequently resolved. Possibly, the difference in actively as opposed to passively generated head movement may account for the apparent discrepancy. Also, our patient had no clear history of anomalous head movement whereas all of the patients described by Gresty et al[1,11] did.

Analysis of the waveforms disclosed that within a single recording session both the frequency of the oscillations and the interocular phase relationships may vary considerably, even from second to second. In two of our patients, a variability in the relative waveform amplitude was recorded during a single session. The characteristics of this dissociated nystagmus varied not only during one recording session but also in different sessions. It should be noted that at times, or even throughout a recording session, the nystagmus may be conjugate and mimic congenital nystagmus.

In addition to the infant in whom we oculographically documented the resolution of the nystagmus, another infant's nystagmus had clinically resolved, and this finding was recorded in her clinic chart. However, her mother noted that nodding was still intermittently present. Even with careful observation, we were unable to detect abnormal eye or head movements on her follow-up videotape record. However, eye-movement recordings corroborated her mother's history since ocular oscillations were

readily apparent. Since our recordings showed that the nystagmus associated with spasmus nutans was still present in one of the two patients in whom it was believed to be clinically resolved, it is possible that in many cases the "resolved" nystagmus had merely declined to a subclinical level. Since the nystagmus is intermittent and not always present in both eyes, it may not be appreciated during an ophthalmoscopic examination.

The cause of this transient condition of infancy and early childhood still remains to be determined. Earlier reports considered the pathogenesis of this disorder related to diverse causes that included light deprivation, dietary factors, season, epilepsy, and poor socioeconomic conditions.[20,21] The report of spasmus nutans in twins points to the importance of genetic factors.[22,23] One study associated a greater incidence of neurologic abnormality in infants and children with ocular oscillations.[21] However, spasmus nutans usually affects neurologically normal children. All other factors, as noted, have been excluded as pathogenetic agents.

Quantitative oculography has been used to analyze the dynamic characteristics of possible eye movements. For acquired pendular nystagmus in adults, Gresty et al[19] suggested a defect in yoking between vertical, horizontal, and torsional ocular motor systems. The disconjugate nature of the nystagmus of spasmus nutans suggests a yoking abnormality. The anatomic location of the defect may lie at the level of the ocular motor nuclei (eg, abducens motoneurons, abducens internuclear neurons, oculomotor neurons, and oculomotor internuclear neurons). In infants with spasmus nutans the abnormality may not represent a static anatomic lesion of the yoking system but, instead, delayed developmental changes in the connections associated with that system. Subsequent modification of these connections may account for both the transient nature and variability of this dissociated nystagmus. One further possible factor in the development of spasmus nutans is an instability due to time delays in the developing ocular motor circuits. Time delays are a common cause of oscillations.

One ocular motor system we initially considered as possibly contributing to development of spasmus nutans is the vergence system.[12] Vergence eye movements facilitate binocular vision. However, vergence eye movements are characteristically slow; the vergence system, in adults, can be made to oscillate at a mean frequency of 2.5 Hz.[24] It would be difficult for such a system to account for the rapid (eg, 11 Hz) ocular oscillations observed with spasmus nutans but could account for the low-frequency oscillations. Moreover, none of the infants we examined showed signs of a strabismus that might indicate an abnormality of the vergence mechanism.

The saccadic system is another ocular motor control system that may account for the development of spasmus nutans. Saccadic eye movements are characteristically rapid. Zee and Robinson[25] previously described and modeled saccadic oscillations. In the patient they described, these oscillations had an approximate frequency of 11 Hz. The model simulation also showed high-frequency conjugate oscillations in the presence of a small delay that caused instability in the eye-position feedback loop. A similar instability of this system may result in the observed rapid ocular oscillations seen in spasmus nutans. However, all of the patients with spasmus nutans whom we examined produced normal saccades.

The pursuit system can also exhibit oscillatory behavior. Recent work by Optican et al[26] evaluated the adaptation of the pursuit system in adult patients with monocular oculomotor palsies. They observed 3-Hz ocular oscillations associated with pursuit under conditions causing high pursuit gain. However, this low-frequency conjugate oscillation cannot account for the dissociated nystagmus of higher frequency that is seen in spasmus nutans.

Spasmus nutans remains a perplexing, self-limiting affliction of infancy and early childhood despite our identification of the characteristics of the resulting nystagmus. Future studies should help elucidate the neural substrate of this disorder. This knowledge will help us use recording for early discrimination between spasmus nutans and other ocular oscillations.

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