Accommodative and Vergence Findings in Ocular Myasthenia: A Case Analysis

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Myasthenia gravis (MG) is a neuromuscular disorder that affects skeletal muscles, in particular, the extraocular muscles. Response variability is a hallmark sign. Detailed findings are described in a patient with MG in which the presenting sign was accommodative insufficiency. Objective accommodative findings were recorded 3 years before the onset of myasthenia, soon after the initial diagnosis was made, and then after the treatment commenced with pyridostigmine. In addition, clinical measurements were obtained periodically at different times of the day for various binocular motor functions, including near point of convergence, phoria, fusional and accommodative amplitudes, and relative accommodation. The disease adversely affected all accommodative and vergence findings, with fatigue being the primary disturbance. The therapeutic administration of pyridostigmine improved static measurements of accommodation and vergence and reduced asthenopia. The objective dynamic measurements of accommodation, vergence, and versions were less affected. These findings provide a clear demonstration that both intrinsic and extrinsic ocular muscles may be affected in the prepresbyopic myasthenic patient.

Key Words: Accommodation—Accommodative insufficiency—Binocular vision—Convergence—Convergence insufficiency—Fatigue—Myasthenia gravis—Strabismus.
Clinical Measurements of Accommodation and Vergence

Shortly after the diagnosis of MG was made, various clinical accommodative and vergence measures over the course of a day (9:00 AM, 1:00 PM, and 5:00 PM) over a 6-month period were taken. These included accommodative amplitude, relative accommodation, relative vergence, and the phoria.

Figure 2 presents monocular accommodative amplitudes as measured with a minus lens to first noted sustained blur (19). The patient was encouraged to exert maximum accommodative effort throughout testing. The right eye had a considerably larger amplitude of accommodation than the left eye (mean difference, 2 D). There was progressive diminution of accommodative amplitude as the day progressed (Fig. 2A). With the administration of pyridostigmine, the amplitude of accommodation increased from 2 to 4 D OD and from 0.50D to 3.5 D OS (Fig. 2B). However, these values were still below the age-related clinical norm of 11 D (29).

Figure 3 presents the relative accommodative measurements over the same period. Negative relative accommodation was normal (+2.50 D OU) and was relatively unaffected by time of day, course of the disease, or the instillation of Mestinon. In contrast, all of these factors clearly affected positive relative accommodation. Positive relative accommodation decreased over the course of the day and improved with the administration of pyridostigmine.

Figure 4A presents the near relative convergence amplitudes at various times of day (9:00 AM, 1:00 PM, and 5:00 PM), whereas Figure 4B depicts near relative convergence over a 1.5-year period. Convergence amplitudes were initially normal but progressively decreased over the course of the day. The mean relative convergence amplitude at 9:00 AM was 13° with a recovery of 8°; at 1:00 PM, the mean convergence amplitude was −4° with a recovery of −2°; and at 5:00 PM the mean convergence amplitude was −15° with a recovery of −12°. With the introduction of Mestinon, the convergence amplitude at 5:00 PM improved to 5° with a recovery of 2°. This was still outside normal limits (i.e., 17/21/11; blur/break/recovery in prism diopters) (30).

Figure 5 presents the change in phoria during the course of the day. The mean exophoria increased as the day progressed. At 9:00 AM, it was 8°, and by 5:00 PM the exophoria had increased to 16°. The increasing phoria accompanied with decreasing convergence amplitudes explains the symptom of diplopia that the patient experienced late in the day.

It is of interest that neither the fusional divergence amplitudes nor concomitancy of versions varied from day to day or over the course of the day. The initial finding of a small left hyperphoria was present at only some of the test sessions.

Laboratory Measurements of Eye Movements

Objective eye movement recordings were performed on the subject at four separate test sessions. Horizontal eye movements (binocular viewing; right eye recorded) were assessed using a commercially available, infrared eye movement system (Gulf and Western, Eye Trac, Model 200). This system has a band width from dc to 250 Hz, a resolution of 0.2°, and a linear range of ±10°; however, the frequency response of the eye movement traces was limited by the bandwidth of the strip chart recorder (dc to 80 Hz). The target consisted of a small (5-minute arc), bright spot of light (3 log units above threshold) controlled by a function generator and presented on a display monitor 57 cm from the subject. It moved predictably at various frequencies specified below at either ±5° or ±10° in amplitude to the left and right of midline.

Emphasis was placed on static and dynamic aspects of saccadic eye movements and their apparent ability to fatigue. After a brief calibration, 6 cycles of 0.4 Hz, 10° predictable step tracking were tested. Saccadic accuracy (with respect to the initial saccade metric) and velocity
profile were within normal limits. Some saccades were slightly hypometric, but the peak velocity/amplitude relation (i.e., main sequence) was in the normal range (31). This was followed by 60 cycles of 0.8 Hz predictable step tracking in an attempt to induce fatigue. Immediately after this, 20 cycles of 0.4 Hz, and then 45 cycles of 0.8 Hz of predictable step tracking were performed. There were no obvious fatigue effects either during or immediately after this fatigue paradigm, such as slowed or overlapping saccades; the metrics and velocity characteristics were as before (31).

Testing was repeated 5 days later, in the morning. For 10° predictable step tracking at various frequencies (0.2-0.8 Hz.), there was evidence of "mild" fatigue effects in 20% of the saccadic movements. Hypometria was now more marked, which reflected reduced saccadic gain. Peak velocities were reduced, with blunted velocity profiles evident. When saccadic amplitude was increased to 20°, at a relatively rapid self-paced frequency of approximately 1.0 Hz, the presence of fatigue effects was increased and now occurred in approximately 50% of the saccades. These fatigue-related abnormalities included markedly slowed saccades with very blunted velocity profiles, marked hypometria, and increased response variability.

The patient was retested on the same day in the late afternoon. Using a similar 10° saccadic fatigue paradigm, there was now little evidence of any fatigue effects.

The patient was retested 5 months later in the late afternoon, after she had begun taking Mestinon. Subjectively, she noticed considerable improvement with respect to overall reduction of general body and ocular fatigue. Once again, the larger 20°, self-paced saccades were tested. After 60 cycles of tracking to induce fatigue, 50 more cycles were tracked. The eye movement characteristics were then qualitatively analyzed with respect to a general profile. Numerous abnormalities were found, including moderately slow saccades, overlapping saccades, and considerable saccadic response variability (31). Moderately slowed saccades were found with movements to both the right and left (Fig. 6).

DISCUSSION

The current results, as well as those reported earlier by two of the authors, are consistent with the notion that accommodative dysfunction may be a more common finding in the presbyopic myasthenic population than previously believed (16). Accommodation fatigued more easily than vergence, pursuit, saccades, or other skeletal muscles (e.g., levator). This is surprising, because MG has traditionally been described as a disease that only affects striated skeletal muscles and not smooth muscles, such as those involved in the control of accommodation. Static measurements of accommodative amplitude and dynamic measurements of accommodative facility are rarely performed in the MG population. This would account for the paucity of such information in the literature, as well as the apparent lack of correlation with symptomatology.

FIG. 5. Phorias were measured at both distance and near during the day. Mean phorometric measurement and the standard deviation are presented.
Magnetic Resonance Venography in Idiopathic Pseudotumor Cerebri

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Objective: To inform clinicians about the use of magnetic resonance (MR) venography in idiopathic pseudotumor cerebri.

Materials and Methods: A prospective study to evaluate for the presence or absence of dural sinus thrombosis using MR imaging and MR venography of the brain in 22 consecutive young, female, overweight patients with typical pseudotumor cerebri.

Results: None of the 22 MR imaging and MR venography studies showed venous sinus thrombosis.

Conclusion: Magnetic resonance venography might not add significantly to the evaluation of typical idiopathic pseudotumor cerebri but may be indicated in atypical cases (e.g., male, thin, or elderly patients).

Key Words: Magnetic resonance venography—Pseudotumor cerebri.

Idiopathic pseudotumor cerebri (PTC) typically affects young obese women. The diagnostic criteria (modified Dandy criteria) for PTC include the following: 1) signs and symptoms related to increased intracranial pressure (e.g., papilledema, headache, transient visual obscurations); 2) no localizing neurologic signs with the exception of unilateral or bilateral sixth nerve palsy; 3) neuroimaging study showing no mass lesion or hydrocephalus, and 4) elevated opening pressure with normal cerebrospinal fluid contents on lumbar puncture (1). A syndrome resembling idiopathic PTC, however, may occur because of dural venous sinus occlusion (2). Magnetic resonance (MR) imaging and MR venography of the brain in 22 consecutive young, female, overweight patients with typical PTC were prospectively performed to evaluate for the presence or absence of dural sinus thrombosis.

METHODS

Consecutive patients referred to the neuroophthalmology service at two tertiary care institutions (Baylor College of Medicine, Houston, TX; and Mayo Clinic, Jacksonville, FL) with the diagnosis of PTC underwent MR venography at the time of their initial MR scan of the head. Informed consents under our respective institutional review board protocols were obtained in all patients. Patients with papilledema due to intracranial lesions or with abnormal cerebrospinal fluid analysis were excluded. All MR scans were reviewed for venous sinus thrombosis by a neuroradiologist and neuroophthalmologist. Specific signs of venous sinus thrombosis included lack of high-flow signal (signal void) from a venous sinus that did not appear hypoplastic or aplastic; or partial or complete filling of the sinus by intraluminal low to intermediate signal intensity thrombus on MR scan and MR venography. Inclusion criteria were age younger than 50 years, female, and overweight meeting the criteria for PTC. Exclusion criteria included patients older than 50 years of age, males, or thin patients.

RESULTS

Twenty-two patients underwent MR scans and time-of-flight MR venography of the head. All 22 patients were young (younger than 40 years) overweight women. All 22 venograms and MR scans showed no evidence of cerebral venous sinus thrombosis.

DISCUSSION

Obstruction of intracranial venous sinus drainage may result in increased intracranial pressure and produce a clinical picture identical to idiopathic PTC. Venous sinus thrombosis may in fact be the mechanism for many of the cases of PTC reported in association with systemic and hematologic disorders, including systemic lupus erythematosus, essential thrombocytopenia, protein S deficiency, anti-thrombin III deficiency, antiphospholipid syndrome, paroxysmal nocturnal hemoglobinuria, Behcet’s disease, meningeval sarcoidosis, hypervitaminosis A, and mastoiditis (1). Purvin et al. (2) retrospectively reviewed the clinical features of cerebral venous obstruction in 20 patients. MR imaging with standard MR pulse sequences was adequate for the diagnosis, but sinus thrombosis was sometimes missed on the initial study (five patients). These investigators believed that special pulse sequences such as MR venography might “serve to highlight further the venous obstruction” (2).
The Pathognomonic Pattern of Accommodative Fatigue in Myasthenia Gravis

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ABSTRACT: We present a case in which the first sign of myasthenia was an accommodative insufficiency with accompanying asthenopia. Accommodative responses were recorded with an infrared optometer. The patient viewed an accommodative stimulus which was moved either sinusoidally or in a square wave pattern. The patient could not respond to an accommodative stimulus which moved faster than 0.2 Hz. Targets moved sinusoidally at 0.1 Hz resulted in spasms of accommodation, larger than normal oscillations of accommodation, and/or accommodative fatigue. Clinical accommodative deficits associated with myasthenia may not be detected with standard accommodative amplitude tests but may be observed with repeated square wave stimuli (i.e. rapid interposition and removal of −1.50 Diopter Sphere OU after verbal reports of clarity). Accommodative dysfunction is a common finding in myasthenia. We suggest that accommodative facility testing be done on all nonpresbyopic, myasthenic patients.

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INTRODUCTION

Myasthenia gravis is a disease affecting the myoneural junction of striated muscle characterized by progressive fatigue and functional loss (1). It is more common in women and affects approximately 1:20,000 persons (2). Clinically there are two types of myasthenia: ocular and systemic. The ocular type is limited to the extraocular muscles and the levator muscle of the eyelid producing diplopia and blepharoptosis. The systemic variant affects any or all the skeletal muscles including those of the eyes. Signs and symptoms in both variants are related to the progressive failure of effective myoneural junction transmission with fatigue.

The relationship of accommodative dysfunction to myasthenia is controversial (3,4). As early as 1900, Campbell and Bramwell reported accommodative involvement in myasthenia (5). Romano and Stark (6) reported a case in which the initial complaint of myasthenia was a pseudomyopia. (The pseudomyopia may have been secondary to convergence induced accommodation initiated as the patient converged to eliminate diplopia.)

Aird (7) and Simpson (8) mention that defective accommodation is associated with myasthenia. However, neither author provided scientific evidence to confirm their speculation. Rabinovitch and Verajaranovsky (9) presented a case study in which a 25-year-old patient with myasthenia complained of near vision difficulty for 13 years. Their patient showed a progressive monocular fatigue of accommodation following reading. This included a 12 diopter reduction in accommodation. With a retinoscope they also measured a bilateral spasm of accommodation which occurred during reading. The spasm varied between 1-4 diopters. They concluded that their patient had a progressive loss of accommodation with compensatory accommodative spasm secondary to myasthenia gravis.

Manson and Stern (10) measured accommodative amplitudes in 6 patients with systemic myasthenia, 3 patients with ocular myasthenia, 11 non-myasthenic patients with accommodative deficits and 17 control patients. They measured accommodative amplitudes ten times, once every 5 sec. The best response was scored. Afterwards, Tensilon™ was injected into all 34 patients. In 5 out of 6 of the systemic myasthenics, the near point was reduced before injection of Tensilon, and normalized after injection. All three of the ocular myasthenics had latent accommodative defects, i.e. reduced amplitudes, which increased after the injection of Tensilon. Six of the 11 non-myasthenic patients with accommodative deficits also improved after injection of Tensilon. None of the 17 control patients experienced any change in their near point of accommodation after Tensilon administration. Manson and Stern concluded from the above that myasthenia affects the smooth ciliary muscle and that most accommodative defects represent a subliminal form of myasthenia. Unfortunately, Manson and Stern did not provide any data in regard to age or change in accommodation after Tensilon injection.

We present a case of ocular myasthenia in which we were able to document the accommodative changes with a dynamic infrared optometer. We found an accommodative fatigue with an infrared optometer which was different from any other functional or pathological accommodative fatigue previously described.
CASE REPORT

A 25-year-old female presented with a complaint of ocular fatigue after 5 minutes of near work, i.e. blurred vision, pulling sensations, and headaches. The first symptoms were noted 12 years ago. Best corrected vision OD +2.00 sph was 20/25 and OS +1.00 + .50 x 95 was 20/25. Initial extraocular movements were full, smooth and concomitant. Cover testing revealed orthophoria at distance and 4 prism dipters of exophoria at near. The near point of convergence was 2"/4". Suppression was noted with all first and second degree binocular stimuli. Vergence testing with vectograms demonstrated both low base-out (break = 9 prism dipters; recovery = 4 prism dipters) and base-in fusional ranges (break = 8 prism dipters; recovery = 5 prism dipters), and induced asthenopia i.e. vague eye strain and fatigue (11). Accommodative amplitudes were normal (7D), but accommodative facility with a ±1.50 flipper lens was abnormal (11,12) (See Fig. 1). The patient could not clear either the +1.50 OU or the -1.50 OU after 3 cycles. Stereopsis was 40 sec on the Titmus stereo test and normal on a random dot stereogram (500 sec) suggesting that both sensorial fusion and bifoveal fixation were present (13).

Due to the lowered fusional ranges, accommodative insufficiency and suppression, weekly sessions of orthoptics were prescribed for the patient. Orthoptic sessions consisted of exercises to extend fusional ranges (smooth incremental vergence changes); step or jump ductions (prism jumps e.g. 0 to 20 diopter steps); and accommodative rock activities (e.g. monocular alternate interposition of plus and minus lenses from +2.50 to -6.00 while viewing a target at 40 cm). Vergence disparity targets were presented in space using vectograms, analglyphs, stereoscopes, and prisms. Each session lasted 30 minutes with home exercises to supplement in-office therapy. Instead of improving, the patient’s symptoms remained the same; neither accommodative nor vergence abilities improved, and orthoptics exacerbated the symptoms, i.e. increased
1200 m. sec) (17) and accommodation finally fatigued completely. At the end of the trial neither the accommodative stimulus nor verbal encouragement were able to elicit a response.

**DISCUSSION**

To the best of our knowledge, this is the first case of recorded accommodative fatigue in myasthenia gravis. As in previously reported cases without recordings (5-10), we found fatigue after our patient maintained accommodation for a period of time. Our patient then showed spasms of accommodation which parallel and were consistent with physiological fatigue of skeletal muscle. Accommodative responses were characterized by large amplitude oscillations occurring at a frequency of 1-2 Hz, and also by both slow and reduced responses. Finally, we observed true total accommodative fatigue which occurred after a few minutes of accommodation. This pattern of accommodative fatigue was unlike other non-myasthenic accommodative deficits previously described (12,18). The pattern of accommodative fatigue in myasthenia is consistent with other skeletal muscle responses in myasthenia and was identical in character to the myasthenic accommodative responses described by others (9,10).

Manson and Stern (10) reported improvement in accommodative functioning following administration of Tensilon in non-myasthenic patients with accommodative dysfunction. Thus, one may argue that all accommodative deficits may be subliminal myasthenia or that complete accommodative fatigue is not specific to myasthenia. However, the systematic rapid fatigue of accommodative function in myasthenia with final loss of all accommodative ability mitigates against this. Patients with accommodative paralysis have no accommodative function. Patients with accommodative insufficiency or accommodative inertia secondary to either muscular fatigue or lens sclerosis slowly fatigue their accommodation. They never deplete all of their accommodative function. Patients with accommodative insufficiency generally need a long refractory period (greater than 5 minutes) to revive their accommodative system; may be helped with minimal plus lenses at near; and the removal of the lens slowly causes blur or fatigue. On the other hand, our patient's accommodation totally and rapidly fatigued but could be rejuvenated quickly. The lens prescription needed to relieve the blur was a +2.50 once fatigue set in. Upon removal of the +2.50 the patient could maintain clarity for a short period of time. These findings suggest that the myasthenic patient suffers from total accommodative fatigue unlike other non-myasthenic conditions.

Standard clinical testing of accommodation, i.e. amplitude testing, will not pick up this deficit since amplitude testing does not measure time related fatigue. Diagnosis may also be determined with repeated monocular accommodative amplitude determination. However, it appears
from our accommodative records that square wave stimulus presentations may fatigue the system more rapidly than sinusoidal presentations. Thus, the accommodative flipper test which is similar to a square wave stimulus presentation on the infrared optometer will result in faster accommodative fatigue than would be found on amplitude testing, which is more like sinusoidal presentation. A -1.50 is placed in front of the eye with the subjective correction in place. As soon as clarity is obtained the lens is removed. Again the -1.50 lens is inserted, and removed after clarity is obtained. The process is repeated for 30 sec. The number of cycles cleared in this time span is noted. A normal finding in young adult is 12 cpm in 30 sec. with a S.D. ± 1.5 (19). A significant deviation indicates a problem in accommodative inertia (flexibility) (17,18).

When the myasthenic patient with an accommodative dysfunction shows rapid loss in accommodative flexibility or total accommodative fatigue a +2.50 will be needed to restore clarity at 16". Therefore, the patient was given a Varilux II progressive lens with a +2.50 add to relieve her accommodative fatigue. We decided on a progressive lens since it gave the patient the option to use any amount of plus lens which removed her accommodative fatigue. Also, the Varilux is extremely beneficial to a young person during periods of total fatigue. This lens allowed her to maintain clarity at all working distances. The patient reported a dramatic reduction in her asthenopia. She currently uses the maximum plus for sustained reading. We know that the complaints were not vergence related since occlusion had no effect on her symptoms, she had suppression on various binocular tests, and never reported diplopia.

Since we are reporting a single case it is difficult to generalize our findings to all myasthenics. However, if Manson and Stern are correct in that all ocular and most systemic myasthenics have accommodative deficits, then accommodative testing is important in the diagnosis and care of the myasthenic patient. Even though accurate measurements require an infrared optometer, simple clinical tests (+1.50 D. Flipper) previously described should be adequate for diagnosis of myasthenia. Further research is needed to confirm these speculations.

**CONCLUSION**

Objective accommodative recordings of a patient with ocular myasthenia gravis revealed the following: accommodative latencies which were longer than normal; an accommodative response which was less than normal; and an accommodative response which underwent complete fatigue in a short period of time. The patient's symptoms were relieved with a progressive lens (Varilux II) which allowed the patient a continuous range of clear vision.

The above findings are similar to those described by Rabinovitch and Vergjenovsky (9). Our findings add additional support to Manson and Stern's contention that accommodative dysfunction is a common finding in myasthenia. We suggest that accommodative facility testing be done on all non-presbyopic, myasthenic patients.

**Key words:** accommodation, accommodative insufficiency, binocular vision, myasthenia, optometer, orthoptics, vergence, vision training.
The Pathognomonic Pattern of Accommodative Fatigue in Myasthenia Gravis

References


