Comparison of Amplitudes of Fusional Vergence in Patients with Asthenopic and Asymptomatic Near Exophoria

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Abstract

***Purpose*:** To compare fusional vergence amplitudes in patients with symptomatic and asymptomatic near exophoria

***Methods*:** This cross-sectional study included 102 patients with near exophoria and asthenopia and 86 with asymptomatic near exophoria, all of whom were aged 15-35 years and had best corrected far visual acuity better than $^{20}/_{25}$. Far and near fusional vergence amplitudes were evaluated in all patients. The subjects were not hyperopic.

***Results*:** We observed significant between group differences in near negative fusional vergence (NFV) break (15.91±4.90 PD vs. 14.73±4.60 PD, p=0.013), near NFV recovery (12.33±3.90 PD vs. 13.79±3.97PD, p=0.009), and far NFV recovery (5.58±3.50 PD vs. 4.50±2.70 PD, p=0.019). Other vergence amplitudes did not differ significantly.

***Conclusion*:** Although previously it was assumed that asthenopia is related to convergence insufficiency (CI), it seems that asthenopia in patients with near exophoria may be related to increased amplitudes of negative vergence.

***Keywords*:** Fusional Vergence Amplitudes, Asthenopia, Near Exophoria

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Introduction

Asthenopia describes complaints related to refractive error and ocular muscle imbalance, including pain or aching around the eyes, burning and itchiness of the eyelids, ocular fatigue, and headaches.[1] In asthenopic and convergence insufficiency (CI) patients, there is typically an exophoria or intermittent exotropia at near, a receded near point of convergence, reduced positive fusional convergence amplitudes, and a low accommodation convergence/accommodation (AC/A) ratio.[2-6] The symptoms associated with CI vary from mild to severe, but they are often extremely troublesome for patients with this condition, specially when associated with a small angle exotropia at the near working distance causing binocular diplopia.[7]

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Nowadays, asthenopia symptom became more common among college students; maybe due to computer use and life style changes. It was mostly because of computer usage and fatigue associated to the effect of display technology on visual fatigue.[8-10] In order to determine if any fusional amplitude factors are responsible for asthenopia or disturbances in binocular vision, we have compared amplitudes of fusional vergence in individuals with asthenopic, symptomatic exophoria and those with asymptomatic near exophoria.

Methods

In a cross-sectional study evaluated 1,000 normal individuals for inclusion. Subjects between 15 and 35 years old were selected. Individuals younger than 15 years were excluded since they may not cooperate sufficiently and those over 35 years were excluded due to the risk of presbyopia. All included subjects had best corrected vision better than $^{20}/_{25}$. Emmetropic, myopic, and myopic astigmatic individuals were included, whereas hyperopic individuals were excluded as hyperopia itself may make them asthenopic. Although it seems that fully corrected hyperopes will be symptom free, as there is no strong document to support it, we have excluded them too. Myopic patients with correction were included. The spherical equivalent of each individual was less than -2.00 diopters to reduce the effect of refractive error. Individuals having a history of ocular or medical diseases were excluded. As dry eye is an important cause of asthenopia, moderate to severe dry eye patients were excluded.

A complete ocular history regarding symptoms of asthenopia was taken from each subject. As eye strain may be due to muscular, psychologic, or environmental etiologies, patients were asked about symptoms such as irritation, tearing, aching around eyes, ocular fatigue, and headache, all of which were regarded as indicative of asthenopia. Patients were asked whether they had these symptoms during near vision (e.g. while reading) or far vision (e.g. while driving), as well as the time from commencing the task to the initiation of symptoms. All subjects underwent a complete eye examination, including the anterior and posterior segments, to rule out other etiologies. Cover, uncover and alternate cover tests, with an accommodative target were performed, both at far (six meters) and near (33 centimeters) distances. Magnitude and direction of phoria were determined. Individuals with manifest strabismus, esophoria or far exophoria were excluded. Although it is generally considered normal to have 0-6 prism diopters exophoria at near, any exophoria at near was included. All tests were performed between 9-11 AM to reduce the effect of daytime fatigue on measurements. Vertical and horizontal prism bars (Horizontal & Vertical Prism Bar Set, Luneau, France) were used to measure amplitudes. Same examiner did all of the testing. Vertical and horizontal heterophoria was induced by increasing prism powers, resulting in a disturbance in binocularity and diplopia, with the break point defined as the total fusional vergence at which diplopia occurs. The prism power was subsequently reduced until a single picture of the object was observed, with the recovery point defined as the amount of vergence when the individual regains single vision after diplopia.

This study was confirmed by the Ethics Committee of Mashhad University of Medical Sciences (research project number 86432). All cases provided written informed consent.

SPSS software (SPSS Inc., Chicago, IL), version 16 was utilized for all statistical analyses, with t-tests for between group comparisons of means.

Results

Of the 1,000 individuals screened, 102 with near exophoria and asthenopia were included. Of these, 51 (50%) were men and 51 (50%) were women; their mean age was 26.53 ±2.86 years. As controls, we included 86 individuals with asymptomatic near exophoria with no evidence of asthenopia. Of these individuals, 40 (45%) were men and 46 (55%) were women; their mean age was 26.13±2.14 years. The mean spherical equivalent was -0.69±0.38 diopters in symptomatic patients and -0.74±0.26 diopters in asymptomatic controls (p=0.36). When we measured near and far convergence, divergence, and vertical amplitudes, we found that near negative fusional vergence (NFV) break (15.91±4.90 PD vs. 14.73±4.60 PD), near NFV recovery (12.33±3.90 PD vs. 13.79±3.97 PD), and far NFV recovery (5.58±3.50 PD vs. 4.50±2.70

PD), differed significantly in the two groups (Table 1). None of the other amplitudes, however, differed significantly.

Table 1. Far and near fusional vergence amplitudes and p-values in both asthenopic and asymptomatic near Exophoric patients

Fusional vergence	Asthenopic near exophoric cases (n=102)	Asymptomatic near exophoric controls (n=86)	p-value
Far			
PFV Break	14.01±6.62	13.36±6.60	0.475
PFV Recovery	9.64±4.23	9.19±5.00	0.513
VFV Break	2.43±1.70	2.36±1.60	0.437
VFV Recovery	1.97±1.20	1.84±0.94	0.948
NFV Break	7.89±4.70	7.20±3.60	0.109
NFV Recovery	5.58±3.50	4.50±2.70	0.019
Near			
PFV Break	34.01±6.62	32.36±6.60	0.308
PFV Recovery	31.64±4.23	30.19±5.00	0.337
VFV Break	2.76±1.70	2.49±1.60	0.553
VFV Recovery	2.01±1.20	1.96±0.94	0.84
NFV Break	15.91± 4.90	14.73±4.60	0.013
NFV Recovery	12.33±3.90	13.79±3.97	0.009

PFV: Positive fusional vergence (Convergence), VFV: Vertical fusional vergence (Vertical), NFV: Negative fusional vergence (Divergence)
The values are in prism diopters.

Discussion

After evaluating 1,000 individuals, we have compared 102 patients with asthenopic near exophoria and 86 with asymptomatic near exophoria. To avoid selection bias, we excluded patients younger than 15 years and older than 35 years, as well as all patients with ocular diseases, systemic problems, hyperopia, or BCVA below $^{20}/_{25}$. Moreover, all tests were performed at 9-11 AM to avoid diurnal variations and patient fatigue. We also excluded individuals with spherical equivalent greater than -2.00 diopters to reduce the effects of myopia induce exophoria.

We found that near NFV break, near NFV recovery and far NFV recovery differed significantly in the two groups. Although these differences are <2 prism diopters, the values obtained are the means of the vergence amplitudes. Our findings suggest therefore that asthenopia may be related to increased NFV amplitudes. In contrast, although we found that the convergence fusional amplitudes were increasing in patients with asthenopic near exophoria, the differences were not significant. We believe that in near exophoric patients, asthenopia is attributed to Increased NFV, means that the patient has the power of compensation of larger amounts of base-in prisms.

To our knowledge, no study evaluating the effect of the NFV on asthenopia of patients with near exophoria has been reported yet. Several studies have evaluated asthenopic symptoms in patients with CI. For example, use of an 8-question questionnaire to quantify symptoms in seven adult patients found that some symptoms were relieved after treatment.[2] In addition, asthenopic symptoms were more frequent in adults with intermittent exotropia than in control subjects with normal binocular vision.[3] Taken together, all of these studies showed that asthenopia is related to CI. A review of CI and its treatment showed that intensive orthoptic therapy is the treatment of choice for CI. Pencil push-ups and use of accommodative targets was shown to be participated in the treatment of CI when part of a more intensive orthoptic program.[4]

Refractive error, primarily myopia, is also involved in exophoria related asthenopia. For example, asthenopia was observed in 23.1% of Swedish schoolchildren; with all but two of these children having abnormal results on eye examinations. Asthenopia was concluded to be related to uncorrected visual acuity and myopia, but not to accommodative or CI.[5,6]

Conclusion

Although CI frequently leads to asthenopia, increased NFV amplitudes may also be involved. A determination of comprehensive regional normative values may make it possible to predict the outcomes of procedures that affect vergences. We believe that a more comprehensive study with more samples and considering the amount of exophoria is needed to evaluate the efficacy of convergence efforts and its relation to exophoric asthenopia.

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