Special Article - Optometry

Non-Strabismic Binocular Vision Abnormalities

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Abstract

Non Strabismic Binocular Vision Anomalies are highly significant and prevalent condition among young generation people who spend most of their time in electronic gazette this condition is often associated with headache, eyestrain and blurred vision. These symptoms are often misunderstood with other binocular vision anomalies unless complete binocular and orthoptic examination is done. Proper diagnosis and treatment can be done with vision therapy exercises which improve quality of life of the patient. This article motivates and provides useful information to detect, diagnose and treat these anomalies.

Introduction

Today in our changing environment and working pattern, the near and intermediate visual task have increased dramatically; consisting of work on computer and related gazettes, reading books, watching television. This needs lots of work to our external eye muscles which leads to eye fatigue. These also give rise to number of binocular anomalies in accommodation & convergence. On cursory examination, we may diagnose it as "computer vision syndrome" [1,2] but on a careful examination, we may realize patient is having other non-strabismic vergence anomalies. Failing to diagnose & treat these symptoms & signs give rise to strabismic problem [3]. In this article we will discuss about various Non-strabismus binocular vision abnormalities and its diagnosis and management. We will enumerate a case which will tell us how orthoptic work up help us in diagnosis a latent squint and how eye exercise help us to overcome this problem of the patient.

A 22 year old male patient came to the Binocular vision department of Hospital with a complaint of intermittent squinting of eyes (eyes deviating outward). He was a software engineer with near and intermittent work on computer and related gazettes for 12-14 hours a day. He did not have any other subjective complain of asthenopia. On evaluation his refractive error was found to be -1.50 Dsph in the right eye and -1.50 Dsph /-0.50 Dcyl 50 in the left eye which was confirmed with cyloplegic refraction and his best corrected visual acuity was found to be 6/6 on both eyes with N6 vision for his near. On cover -uncover test he did not have any obvious tropia but alternate cover test showed exophoria.

On Binocular Vision evaluation his sensory status was found well within normal limits as his fusion was present on worth four dot test and steropsis was found to be 40 secs of arcs on titmus fly test. His near point of accommodation was found to be within the normal limits checking with RAF rule. His near point of convergence was found to be till tip of the nose on checking on ten occasions with RAF rule.

His phoria value was 10 prism diopter base in for distance and 9 prism diopter base in for near. His Accommodative Convergence/Accommodation values (AC/A) was 4:1 checked by gradient method. His accommodation amplitude was checked by minus lens method and was -10.00 Dsph unioccularly and was confirmed

by push up method test. His accommodative dynamic was also checked by accommodative facility and was 14 cycles per minute and his accommodative response which was check by Monocular Estimation Method (MEM) was +0.75 Dsph. His Negative Relative Accommodation (NRA) and Positive Relative Accommodation (PRA) values were +4.50 Dsph & -6.50 Dsph. His Positive Fusional Vergence (PFV) was 10 prism diopters blurs, 15 prism diopters break & 16 prism diopter recovery for distance. For near his, Positive Fusional Vergence (PFV) was 15 prism diopter blur, 20 diopter break, 20 prism recovery. His Negative Fusional Vergence (NFV) was 6 prism diopters blur for distance, 10 prism diopter break, 8 prism diopter for recovery. For near, his Negative Fusional Vergence (NFV) was 10 prism diopter blur, 14 prism diopter break, 12 prism diopter recovery.

This Binocular findings were compared to those with Morgan table of expected values & optometric extension program values [4,5]. Based on our findings, we diagnosed him as "high exophoria for distance and near with reduced positive fusional vergence".

The patient was called for exercise and his exercise was planned in three different phase. Phase 1, he was given exercise with brock string and cat card in the orthoptic department to increase his voluntary convergence. In Phase 2 of the exercise, the exercise of phase 1 was given as home exercise and variable tranaglyphs to increase his Positive Fusional Vergence (PFV) with voluntary convergence. In the Phase 3 patient was given eccentric circles with variable tranaglyphs to increase his positive fusional vergence for near.

After 2 weeks of phase I exercise, the patient was reevaluated and his phoria values decreased from 10 prism diopter to 7 prism diopter and his Positive Fusional Vergence (PFV) increased from 20 prism diopter break to 25 prism diopter break and his accommodative remains the same which was within the normal limits.

In Phase 2 of the exercise, the phase 1 exercise was given as home exercise and variable tranaglyphs to increase his positive fusional vergence with voluntary convergence which will decrease his squinting of eyes and increase his binocular vision. In the Phase 3 patient was given eccentric circles with variable tranaglyphs to increase his Positive Fusional Vergence (PFV) for near as it was not decreasing for near. Patient was evaluated for orthoptic values after completing his exercises and he was orthophoric for distant and near.

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Table 1: Classification of binocular vision disorder.

Low AC/A
1. Orthophoria at distance, exophoria at near- convergence insufficiency
2. Exophoria at distance, more exophoria at near
3. Esophoria at distance - divergence in sufficiency
Normal AC/A
1. Orthophoria at distance - fusional vergence dysfunction
2. Exophoria at distance - basic exophoria
3.Esophoria at distance - basic exophoria
High AC/A
1. Orthophoria at distance, esophoria at near
2. Esophoria at distance, more esophoria at near - convergence excess
3. Exophoriaat distance - divergence excess

This case shows problem of our current life style, its problem on the eye and more importantly appropriate work up and its management.

We will briefly describe various binocular vision problems and its management.

According to the wick [6,7] there is a nine possible classification of binocular vision problem based on AC/A ratio. The three categories are low AC/A ratio, high AC/A ratio, normal AC/A ratio, within which three subdivision are found (Table 1).

Category 1: Low AC/A

Orthophoria at distance: Convergence insufficiency

This type of patient has orthophoria at distance (normal tonic vergence) a low AC/A ratio and moderate to high exophoria at near.

Symptoms

All of the following are associated with reading or other near tasks

- Asthenopia and headache
- Intermittent blur & diplopia
- Symptoms worse at end of day
- Burning and tearing
- Inability to concentrate
- Sleepiness when reading
- Slow reading

Signs

- Moderate to high exophoria or intermittent exotropia at near
- Reduced PFV at near
- Reduced vergence facility at near with base out prisms
- Intermittent suppression at near
- Receded near point of convergence
- Low AC/A
- Low MEM

- Low NRA
- Exo fixation disparity at distance and near

Exophoria at distance: Convergence insufficiency

This type of patient has exophoria at distance (low tonic vergence) and low AC/A ratio, and thus the near phoria will be significantly greater than the distance phoria. These patients differ from the previous type of exophoria in which the patient is orthophoric for distance.

Symptoms

Symptoms would be similar to Convergence Insufficiency.

Signs

- Greater exophoria at near than at distance

Treatment Modalities

Phase I

Accommodative and peripheral stereo enhancement

The goal of this stage is develop adequate accommodative function.

Monocular minus lens rock

Monocular plus rock

Phase II

Central stereo and binocular skills enhancement

The goal of this stage is twofold. The first is to equalize the skills between both eyes and eliminate gross suppression. Second is to begin restoring the normal positive fusional vergence amplitude.

Technique: Alternate Rock, Split rock

Phase III

Flat fusion and anti-suppression

The goal of this phase is to expand on phase II by adding increasing numbers of targets that require mostly flat fusion.

Technique

Anti-suppression, Aperture rule

Phase IV

Accommodative and convergence flexibility

The goal of this stage is to teach the patients base out fusion in a closed looped system with accommodation.

Technique

Binocular rock with suppression controls

Variable prismatic mirror stereoscope

Tranaglyphs with flippers [8].

Esophoria at distance: Divergence insufficiency

Distance esophoria is higher than near esophoria.

Symptoms

• Asthenopia associated with distance tasks

• Intermittent blur and diplopia at distance

• Symptoms worse at end of day

Signs

• Exophoria greater at distance than at near

• Reduced NFV at distance

• Reduced vergence facility at distance with base in prism

• Exofixation disparity at distance

Treatment modalities

The patients with low AC/A ratio orthophoria for distance and exophoria for near, or less exophoria for distance and more exophoria for near, can be treated with vision therapy exercises. We can divide the exercise into three phases [9,10].

Phase I

We need to first normalize or train the patient for

1) Voluntary convergence: this can be done with brock string, where patient needs to fixate at one point of the string and needs to appreciate diplopia for other two point of the string. The principle of this exercise is to work with physiological diplopia.

2) Positive fusional vergence: this can be done with tranaglyphs. Here patient needs to put red and green filters on his two eyes and needs to observe two fusional targets with red and green contour and patient needs to make it single with different prism diopter separation, target range is 30 prism diopter.

Phase II

We need to normalize

1) Negative fusional vergence amplitude.

2) Normalize Positive Fusional Vergence Facility

3) Normalize Negative Fusional Facility

Category 2: Normal AC/A ratio

Orthophoria at distance: Fusional vergence dysfunction

This patient has orthophoria at distance and near or a low degree of eso-or exophoria at distance and near. Fusional vergence dysfunction is a disorder in which the fusional vergence ranges are reduced in both the base in and base out directions. Other conditions that must be considered when a patient is symptomatic, in spite of an insignificant phoria are aniseikonia, cyclophoria, latent hyperopia, and hyperphoria.

Symptoms

All of the following are associated with reading or other near tasks:

• Asthenopia and headache

• Intermittent blur

• Symptoms worse at end of day

• Burning and tearing

• Instability to concentrate

• Sleepiness when reading

• Slow reading

Signs

• Orthophoria or a low degree of eso-exo phoria at distance and near

• Reduced NFV and PFV at distance and near

• Reduced vergence facility at near and possibly at distance, with both base-out and base in

• Low PRA and NRA

• Fails binocular accommodative facility with both plus and minus lens

• Normal monocular accommodative facility.

Treatment modalities

Phase I

Monocular Motility: +0.50D sphere over prescription

Monocular Accommodative rock

Phase II

Anti-suppression, Binocular motility and binocular accommodation

Phase III

Fusional range enhancement and binocular motility and accommodation

Phase IV

Accommodative-convergence flexibilty

Phase V

Visualization and tachistoscope work:

Goal to range extension, SILO and accurate localization and jump vergence [11].

Exophoria at distance: Basic exophoria

This patient has exophoria at distance and normal AC/A ratio, and thus the near phoria will be approximately equal to the distance phoria.

Symptoms

• Asthenopia associated with distance and near tasks

• Intermittent blur and diplopia at distance and near

• Symptoms worse at end of day

Signs

• Exophoria of approximately equal magnitude at near and at distance

• Reduced PFV at distance and near

• Reduced vergence facility at distance and near with base out prism

• Low NRA

• Fails binocular facility with plus lenses

• Low MEM and cross cylinder findings

• Exofixation disparity at distance and at near

Esophoria at distance: Basic esophoria

This patient has esophoria at distance (high tonic vergence) and a normal AC/A ratio and thus the near phoria will be approximately equal to the distance phoria.

Symptoms

• Asthenopia associated with distance and near tasks

• Intermittent blur at distance and near tasks

• Intermittent diplopia at distance and near

• Symptoms worse at day

Signs

• Esophoria of approximately equal magnitude at near and at distance

• Reduced NFV at distance and near with base in prism

• Low PRA

• Fails binocular accommodative facility with minus

• High MEM

• Esofixation disparity

Treatment modalities

In treatment modalities for basic exophoria and estropia the exercise and the instrument will remain same but we need to use it for convergence or divergence.

Phase I

Phase I of the exercise will be the same protocol for treatment of low AC/A ratio [12].

Phase II

In Phase II exercise and instruments will remain same but both positive (convergence) and negative (divergence) exercise will be given so,

We need to normalize

1) Positive and Negative fusional vergence amplitude

2) Normalize Positive Fusional Vergence Facility

3) Normalize Negative Fusional Facility

We usually give following exercises

• We can change the fixation of the patients from one point of fixation to another.

• We can tell the patient to look at a distant fixating target and ask the patient to cover and uncover his/her both eyes

• We can also use loose prism or flip prism to create vergence facility.

• Flip lenses to create a step vergence change in vergence demand

• Polaroid or red green flippers can be given to increase the accommodative and vergence facility.

Other valuable technique at this stage

• Aperture rule with single aperture for convergence and double aperture for divergence both is required for basic exo and eso phoria.

• Eccentric Circles can be given as home exercise for positive and negative divergence

Endpoint: The endpoint of phase 2 is reached when the patient can:

• Fuse card 12 using convergence and card 6 using divergence with Aperture Rule.

• Fuse the eccentric circles or free space Fusion Cards using convergence (12cm separation) and (6cm separation).

Phase III

Until this point, the patient has either worked with separately with convergence techniques or divergence technique. Now the objective will be to develop the patient ability to change from convergence to a divergence technique.

1) Vectogram with Polaroid filters

2) Tranaglyphs with red green filters should be used be used for convergence and divergence

Category 3: Binocular Vision Disorder with High AC/A Ratio

Orthophoria at distance: Convergence excess

This type of patients has orthophoria at distance (normal tonic vergence) and a high AC/A ratio. There is a significant amount of esophoria at near.

Symptoms

• Asthenopia and headaches

• Intermittent blur and diplopia

• Symptoms worse at end of day

• Burning and tearing

• Inabilty to concentrate

• Words move on the page

• Sleepiness when reading

• Slow reading

Signs

• Significant esophoria at near

• Reduced NFV at near

• Reduced vergence facility at near with base in prism

• Low PRA

• Fails binocular accommodative facility with minus lenses

• High MEM and cross cylinder findings

Esophoria at distance: Convergence excess

This patient has low to moderate degree of esophoria at distance (high tonic vergence) and a high AC/A ratio as well. Thus, the degree of esophoria at near will be significantly greater than that at distance.

Symptoms

All of the following are associated with reading or other near tasks.

• Asthenopia and headaches

• Intermittent Blur

• Intermittent diplopia

• Symptoms worse at end of day

• Burning and tearing

• Inability to sustain and concentrate

• Words move on the page

• Sleepiness when reading

• If the esophoria is large enough at distance, there may be symptoms of intermittent diplopia blur, and asthenopiaat distance as well.

Signs

• Esophoria greater at near and at distance

• Reduced NFV at distance and near

• Reduced vergence facility at distance and near with base-in prism

• Low PRA

• Fails binocular accommodative facility with minus

• High MEM and cross cylinder findings

• Esofixation disparity at distance and near

Treatment modalities

Phase I

Accommodative and peripheral stereo enhancement

The goal of this stage is to develop adequate accommodative function and to begin to bulid peripheral stereo (especially Base In) at distance.

Technique

Monocular Minus rock in space: plano to -6.00D

Monocular rock plus and minus

Base in children reading cards

Phase II

Central stereo and binocular skills enhancement

The goal of this stage is again twofold. The first goal is to equalize the skills between both eyes and to eliminates any gross suppression. The second is to start restore normal negative fusional vergence amplitues.

Techniques

Alternative rock

Split rock

Phase III

Flat Fusion and anti suppression

The goal of this phase is to expand phase II by adding more techniques that requires flat fusion with suppression control.

Techniques

Binocular Accommodative rock

Anti-suppression

Life saver cards

Accommodative-convergence flexibility

The goal of this phase is to teach the patient base-in fusion with accommodation activated. This phase is designed to create reserves in both the accommodative and fusional vergence system and to restore normal vergence facility and amplitues during sustained visual tasks.

Techniques

Binocular rock with suppression controls

Variable prismatic mirror stereos cope

Tranaglyphs with flipper [13]

Exophoria at distance: Divergence excess

This patient has to moderate degree of exophoria at distance (low tonic vergence) and a high AC/A ratio. Thus the degree of exophoria at near will be significantly less than that at distance.

Symptoms

• Parents complain of eye turning out

• Occasional near point asthenopia

• Child closes one in bright light

Signs

• Greater exophoria or intermittent exotropia at distance than at near

• High calculated AC/A ratio

• Suppression at distance

• Normal near point of convergence

• Limited NFV, adequate PFV

• Difficulty with first and second degree fusion

Generally normal streopsis at near

Treatment modalities

The patients with high AC/A ratio orthophoria for distance and esophoria for near, or less esophoria for distance and more esophoria for near, this type of condition can be treated with vision therapy exercises.

Phase I

Motility and monocular accommodative rock use plus or prisms appropriate.

Phase II

Binocular Motility and accommodation.

Phase III

Build fusional ranges at near point with stereo targets and working through plus lens.

Binocular accommodative rock with suppression controls.

Pointer in straw-at close and then move abck

Phase IV

Build flat fusional ranges at near point

Stress base in and base out, work through plus.

Phase V

Build fusional ranges at intermediate and work towards distance.

Brock stereo motivator-Start closes and moves away

Pointer in straw- near to far

Vectogram- near to far

Phase VI

Accommodative-Convergence flexibility [14]

Classification of Accommodative Anomalies [15-17]

Accommodative insufficiency

Characteristics

Symptoms

• Symptoms are very similar to those associated with presbyopia

• Blurred near vision

• Discomfort and strain associated with near tasks

• Fatigue associated with near point tasks

• Difficulty with attention and concentration when reading

Signs

• Low accommodative amplitude

• Low PRA

• Fails monocular and binocular accommodative facility with minus lenses

• Esophoria at near

• High MEM and fused cross cylinder.

Treatment modalities

Phase I

Monocular rock

Goal: Ensure that monocular amplitude and facility are adequate and equal between both eyes. Facility includes both simulation and relaxation of accommodation.

Phase II

Binocular rock

Goal: equalize both eyes, ensuring that each can alternately shift focus in an unfused situation.

Phase III

Binocular rock

Goal: To develop an accurate and appropriate binocular accommodative fusional system with normal accommodative and vergence facility.

Phase IV

Accommodative-Convergence flexibility [18]

III Sustained accommodation

Symptoms

• Symptoms are very similar to those associated with accommodation insufficiency

• Blurred near vision

• Discomfort and strain associated with near tasks

• Fatigue associated with near point tasks

• Difficulty with attention and concentration when reading

Signs

• Normal accommodative amplitude if administered just once, the amplitude decreased repeated

• Low PRA

• Fails monocular and binocular accommodative facility with minus lenses, the performance will decrease over time

• Esophoria at near

• High MEM and fused cross cylinder

Treatment of accommodative anomalies

The treatment protocol for accommodative problem is different form vergence anomalies and AC/A ratio problem [19].

Phase I

In phase I of accommodative exercise we use added minus lenses to stimulate accommodation. Initially Minus lenses are used alone and in late stages, minus lenses are used along with plus lenses to stimulate and relax accommodation with Hart chart and loose lens

rock test. The interaction of accommodation and convergence is also taken care of in this phase.

Phase II

We can use plus and minus lenses with order to stimulate and relax accommodation, and also binocular exercise procedure like accommodative flippers, bar readers, binocular facility with targets such as vectograms and tranglyphs.

Phase III

During Phase III the emphasis is on integration of accommodation and binocular therapy. Phasic binocular techniques like Aperture rule, eccentric circles, free space cards in different position of gaze.

Accommodative excess

Symptoms

• Asthenopia and headaches associated with near tasks

• Intermittent blurred distance vision

Signs

• Variable visual acuity

• Variable static and subjective

• Low degree of against the rule

• Low MEM and fused cross cylinder

• Low NRA

• Esophoria at near and possibly at distance

• Fails monocular and binocular accommodative facility with plus lenses

Treatment

The treatment protocol for accommodative excess is just the opposite for accommodative in sufficiency [20].

Phase I

The first goal of the therapy itself is to improve the patient's ability to relax accommodation. The procedure used are Hart Chart, loose lens rock test with plus lenses. It is also helpful to simultaneously work with divergence techniques. The objective is to relax and stimulate accommodation.

Phase II

In relation to phase 1 we may need to check the accommodation speed of the therapy especially with plus and minus lenses, so that it can relax and stimulate accommodation. We should work with binocular procedures like binocular facility targets such as vectogram and tranaglyphs

Phase III

During Phase III, the emphasis is on integration of accommodation and binocular therapy. Phasic binocular techniques like Aperture rule, eccentric circles, and free space cards in different position of gaze should be tried.

Accommodative infacility

Symptoms

• Difficulty focusing from distance to near and dear to distance

• Asthenopia associated with near tasks

• Difficulty with attention and concentrating when reading

• Intermittent blur associated with near tasks

Signs

. Fails binocular and monocular accommodative facility with plus and minus lens

. Low PRA and NRA

Treatment protocol for accommodative facility [20]

Phase I

• Develop feeling of diverging and converging, looking close and looking for accommodating and relaxing accommodation

• Normalize negative and positive fusional vergence amplitude at near (smooth and tonic vergence demand)

• Normalize accommodative amplitude and ability to stimulate and relax accommodation.

End Point: Phase I of therapy ends when the patient can

• Clear +2.00/-6.00 lenses clearly monocularly with 20/30 pint size

• Fuse up to 30 prism using convergence and 15 prism using divergence with the tranglyphs or other convergence technique

• Fuse up to 45 prism using convergence and 15 prism base in using divergence with the computer orthoptic random dot program.

Phase II

• Normalize Positive Fusional Vergence (PFV) amplitudes (smooth or tonic vergence demand)

• Normalize Negative Fusional Vergence (NFV) facility at near (jump or phasic vergence demand)

• Normalize PFV facility (jump or phasic demand)

End point: Phase II exercise ends when patient can

• Clear +2.00 Dsph/-6.00 Dsph lenses binocularly with 20/30 pint size with 15 cpm

• Fuse card 12 using convergence and card 6 using divergence with aperture rule.

Phase III

• Normalize NFV amplitude at intermediate distances

• Normalize NFV facility at far

Ocular motility dysfunction

Some clinician classify ocular motor problem into saccadic and pursuit dysfunction. It is rare to find difficulty in only one area. Generally, patients with ocular motor problems have problems with

fixation, saccades and pursuits.

Symptoms

- Excessive head movement during reading
- Frequent loss of place
- Omission of words
- Skipping lines
- Short attention span
- Difficulty copying from the board
- Poor performance in sport

Signs

Below grade-level performance on visagraph

Score below the 5th percentile on Developmental eye movement test

Score below the 15th percentile NSUCO ocular motor test.

Treatment modalities

Treatment should begin at level commensurate with an individual's ability and level of performance.

Techniques should be in corporate both pursuit and saccadic eye movements combined with overall feedback.

Phase I

Monocular skills: Goal to equalize and develop monocular ocular motility skills.

- Techniques
- Feedback (flashlight, beepers, computer)
- Eye-hand coordination (tactual/kinesthetic support)

Inter-sensory integration (auditory integration with a metronome for rhythm.

Phase II

Biocular skills: Goal to equalize skills between both eyes and eliminate suppression if necessary with flowing:

Prism, polarized filters, red-green glasses, septum

Phase III

Binocular Skills: Goal to adequate binocular ocular motility skills may start to use techniques that integrate accommodation, convergence or both.

Techniques

- Feedback
- Eye hand coordination
- Intersensory integration [21-26].

To classify these anomalies to investigate them and to treat them, clinician needs skills & knowledge about the subject. Apart from routine eye examination, we also need to check the other parameters of our ocular health to avoid accommodative, convergence & Fusional vergence anomalies. We can measure phoria with help of Maddox rod, which is present in our trial box. We can check the amplitude of accommodation and other accommodative test with the help of plus and minus lenses with the help of worth four dot test. We can check the positive Fusional vergence & negative Fusional vergence with the help of prism bar cover test. These tests can be performed in our normal set up with very less chair time & less investment for a young clinician. This test tells us about patient binocular status & normal functioning of two eyes, which normally goes untreated and undiagnosed as we all are unaware about the magnitude of this problem.

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