ABSTRACT

Purpose: To report the study design and methods of the “Binocular Vision Anomalies and Normative Data” (BAND) study in school children in Tamilnadu.

Methods: This is a cross-sectional study with an estimated sample size of 936 in rural and urban arms of Tamilnadu. A total of four schools with similar socio-economic factors have been selected in the rural and urban arm and children between 7 and 17 years of age are included based on simple random sampling. All children will undergo an initial screening protocol, followed by comprehensive binocular vision assessment. Children who are asymptomatic and who pass the comprehensive binocular vision assessment.

Keywords: accommodation, Binocular vision, convergence, Normative data, School screening
protocol will be included in the normative data study and children who fail the binocular vision assessment protocol will be included in the binocular vision prevalence study. Vision therapy will be provided to children with symptomatic BV anomalies and binocular vision assessment will be repeated after vision therapy. The primary objectives are to calculate prevalence estimates of binocular vision (BV) anomalies, and development of normative data. After the prevalence estimates are calculated, receiver operating characteristic (ROC) analyses will be performed for the binocular vision tests to find the tests that have the maximum sensitivity and specificity. After the ROC analyses, re-assessment of prevalence with the minimum test battery will be carried out.

Conclusion: This study is expected to provide the prevalence data for binocular vision anomalies in rural and urban Tamilnadu and normative data for binocular vision testing.

According to the American Optometric association (AOA) (1998), diagnosis and treatment of binocular vision anomalies should be a priority aim for the pediatric population as accommodative and vergence dysfunctions can significantly impair the reading performance of a child especially after third grade due to the increasing visual demands. Non-strabismic Binocular vision anomalies (NSBVA) were found to be more common among school children between 9 and 13 years. Convergence insufficiency (CI) and accommodative insufficiency were common in school children between 8 and <15 years of age and these children were more symptomatic than the children in the normal binocular vision group. According to a study by Borsting et al, 77.9% of children who are diagnosed with CI have accommodative insufficiency (AI) as the primary or co morbid cause; similarly 4.7% and 3.3% of elementary school children have AI as the primary diagnosis or co morbid cause respectively, resulting in increased symptoms. But most importantly, children may not realize that reading should be a comfortable experience. In addition, because non-strabismic binocular vision anomalies cannot be detected without clinical tests, parents and teachers are unable to determine if there is a vision problem just based on observation. Children with reading difficulties present with poorer accommodative facility, vergence facility, near point of convergence and accommodation and slower reading speed compared to age matched controls. Appropriate spectacle prescription and vision therapy play a key role in the remediation of symptoms in these children.

To the best of our knowledge, there are no prevalence data in the Indian literature for binocular vision anomalies. Hospital-based studies report varied frequencies of CI from 3.6% to 7.7%. Among school children in Nepal, the reported prevalence of CI is 2.49%. Recent Caucasian prevalence of non-strabismic binocular vision anomalies have been reported to be as high as 56.2% in the general adult population between 18-38 years and 15.3% among University students. Among children between 8 and 12 years reporting to a clinical set-up, definite CI has been reported to be 17.6% and the suspect categories comprise almost 50% of the sample. Such high prevalence rates suggest the need for timely assessment, appropriate diagnosis, and management to improve the vision-related quality of life of these individuals.

A pre-requisite for classifying children as having normal or abnormal binocular vision, is the availability of normal mean values for the battery of different tests conducted as part of the binocular vision assessment. In India, the diagnosis of binocular vision anomalies is currently based on the Caucasian normative values from Morgan et al (1944) and Duane et al (1926). Racial differences in binocular vision parameters have been reported in literature and this suggests the need for Indian specific data. Hence, our objectives are to determine the prevalence of binocular vision anomalies among school children in rural and urban Tamilnadu
along with the determination of normative data for binocular vision parameters in this population. Estimates of binocular vision anomalies among school children will help in planning appropriate assessment and intervention. Moreover the normative data will have significant implications for the clinical practice and management of binocular vision anomalies.

Hence the objectives of this study are:
1. To estimate the prevalence of binocular vision anomalies among school children in rural and urban Tamilnadu
2. To collect normative binocular vision data of for school children
3. To arrive at the minimum test battery needed to pick up binocular vision anomalies in a community set up
4. To re-assess prevalence in the community to validate the minimum test battery

**METHODOLOGY**

This project has been approved by the Institutional Review Board of Vision Research Foundation (VRF) and follows the guidelines proposed by declarations of Helsinki. The study consisted of three phases.

**Phase I: Training Program**

Two optometrists who will participate in the study (AR, NK) will be trained and assessed for intra-examiner agreement with the principal investigator (JRH) of the study. The parameters of concern for the repeatability assessment include near point of convergence (NPC) with accommodative target, near point of accommodation (NPA), and distance and near fusional vergence amplitudes. The rest of the binocular vision tests are carried out by a single examiner at the study site. The repeatability cut-off for negative fusional vergence (NFV), positive fusional vergence (PFV), and NPC have been adopted from Rouse et al (2002). Binocular vision assessment will be performed on 30 subjects and the Altman-Bland agreement will be determined. If the agreement for all the tests is not found to be within the clinically agreeable limits for test-retest variability, re-training will be given and the same process will be repeated.

**Phase II. Epidemiological Field Work**

The principal investigator presented the details of the project to the school administration and written informed consent has been obtained from the school authorities, along with oral consent from the parents. A meeting was organized to explain the project and procedures to the parents. An awareness session on common ocular diseases and binocular vision anomalies was presented to the students, and teachers.

The field work for the study began in February, 2014 and will be completed by December, 2015. The schools in rural and urban arms have been identified based on non-probability convenience sampling depending on acceptance from the school administration. After the sampling frame and sampling unit is identified, subject enrolment will be carried out based on simple random sampling.

**Study Zones:**

An area with a minimum population of approximately 5000, with a density of 400/square kilometre and 75% of the male population engaged in non-agricultural activities is termed as Urban and the rest of the areas are defined as Rural for the study, based on the Indian Census definition (1981).

In rural arm, two schools have been identified in villages of Sricity (adjacent to Tiruvallur district, Tamilnadu) and in one village of Sankarankoil (Tirunelveli district) respectively. In the Urban arm, two schools have been identified in the Tambaram Municipality (Kanchipuram district).

**Vision Screening and Eye Examination**

The steps involved in the vision screening process are listed in Table 1 and the inclusion and exclusion criteria in Table 2.

**Phase III A: Binocular Vision Screening Protocol**

The pass criteria for the screening protocol are:
1. Visual acuity better than or equal to 20/30 at distance and near
2. No symptoms of asthenopia, eyestrain, blurred vision, difficulty associated with reading
3. Stereo acuity > 100” (Randot stereo test)
4. No constant or intermittent strabismus as detected using the cover test

No cut-off has been considered for NPC, accommodative amplitude, phoria and vergence parameters as the main outcome is to estimate normative data for these parameters in the asymptomatic children. Subjects who fail the screening criteria are considered to have binocular vision anomaly and subjects who pass the above mentioned criteria are included for the normative project. But this does not diagnose the subject to have normal BV, until they clear the comprehensive BV assessment. Asymptomatic subjects who do not report any difficulty during the BV assessment will be included for the normative data. There could be subjects who are asymptomatic and have a BV anomaly and there could be subjects who have low level of symptoms but still have normal BV.

**Table 1: Steps in the vision screening**

<table>
<thead>
<tr>
<th>Steps</th>
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<tbody>
<tr>
<td>1. Screening using a visual acuity cut-off of 6/9 using the ESO Pocket vision screener</td>
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<td>2. Ocular motility using the Broad H test</td>
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<td>3. Pupillary assessment and torch light examination for gross ocular abnormalities</td>
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<tr>
<td>4. Static retinoscopy and subjective acceptance using log MAR chart for children with refractive errors</td>
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<tr>
<td>5. Stereo acuity for near using Randot stereo plates</td>
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<tr>
<td>6. If a subject is found to have refractive error for the first time or if a change in refractive error of more than 0.50 D is detected during the refraction, glasses will be prescribed and binocular vision assessment will be done after 2 weeks of glass prescription. Tolerance limits for refractive errors were adopted from the CITT protocol (Scheiman et al, 2005)</td>
</tr>
<tr>
<td>7. Referral of children with strabismus, amblyopia and other ocular abnormalities to the base hospital</td>
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<tr>
<td>8. After vision screening and eye examination is done, inclusion of subjects for prevalence data and normative data will be done based on the inclusion/exclusion criteria.</td>
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<tr>
<th>Table 2: Inclusion and Exclusion criteria</th>
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<tr>
<td><strong>Inclusion criteria</strong></td>
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<tr>
<td>Subjects in the age range of 7 and 17 years</td>
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<tr>
<td>Best corrected visual acuity better than or equal to 6/9, N6</td>
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<tr>
<td><strong>Exclusion criteria</strong></td>
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<tr>
<td>Ocular abnormalities/strabismus (constant and intermittent)</td>
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<tr>
<td>• History of any previous intraocular/squint surgeries</td>
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<tr>
<td>• Self-reported history of ocular/head trauma</td>
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<tr>
<td>• Self-reported h/o Juvenile diabetes</td>
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**Figure 1** Flowchart depicting the recruitment of subjects for the study

This combination will be specifically looked for during the analyses and these subjects will be reassessed prior to classifying them to one of the two groups of normal BV versus NSBVA.

The flow of the recruitment of subjects is depicted in Figure 1.

**Phase III B: Detailed Binocular Vision Assessment**

The room where binocular vision assessment is done will be standardized for illumination levels (minimum of 480 Lux will be ensured) and a minimum length of 6 metres will be chosen to perform vision tests and binocular vision assessment for distance and near.
The outcome parameters in our study include the near point of convergence (NPC), phoria measures for distance and near, vergence amplitudes, vergence facility, Near point of accommodation (NPA), accommodative response, and accommodative facility.

Tests for Vergence

Different targets for Near Point of Convergence (NPC) testing have been reported in the literature. In our study, considering the age range to be tested, NPC will be assessed using two methods 1) an Astron International rule consisting of linear accommodative target of 6/9 reduced snellen letters and 2) using a penlight with red filter in front of right eye. The accommodative target procedure has been used extensively in the clinical set up and its reliability has been well established. Penlight with red filter is considered to be a sensitive test in diagnosing CI as it tests for the maximum fusional ability of the subject eliminating the demand for accommodative convergence. The measurements will be taken from the centre of the forehead as the Zero reference point. The break values are noted at a point when the patient reports doubling of images and the examiner also notes down objectively the deviation of one of the eyes when fusion is lost. Both the tests are repeated thrice and the average of the three measurements will be recorded as NPC. Both break and recovery values will be noted down. NPC maintained up to the center of the forehead will be given a value of 1 cm for analyses purposes.

Heterophoria testing is an important part of routine optometric testing and diagnostic in binocular vision testing. Presence of heterophoria and the magnitude of deviation will be assessed using the Modified Thorington test using a Bernell Muscle Imbalance Measure (MIM) card. Among the various different techniques available like Von-Graefe, Prism cover test, Maddox rod testing, etc, Modified Thorington (MT) method has been recommended by many authors for its simplicity, control of accommodation and high reliability and repeatability. Also this test is useful for children in whom measurement of phoria using prisms is difficult as this test eliminates the need for prism and thereby prism induced blur in one eye that could influence the accommodative demand of the target. The horizontal and the vertical deviation will be assessed at a distance of 3 m and 40 cm. The subject will be put with a trial frame with the Maddox rod oriented in the right eye horizontally and vertically for horizontal and vertical deviations respectively. The subject will be asked to report the position of the red streak on the horizontal and vertical numbers and the appropriate prism deviation will be noted down from the MIM card. If the red streak is reported out of the MIM card, or in case of unreliable responses, prism cover test will be done to assess the magnitude of heterophoria.

The calculated AC/A ratio will be calculated using the expression $AC/A = IPD + FD \times (NP - FP)$ where IPD in centimetres, Near Fixation distance (FD) in metres, and near and far phoria (NP & FP) values in Prism Diopters are fed into the equation. IPD will be assessed using the Essilor® Pupillometer. Fusional vergence amplitudes will be assessed using step vergence technique using a prism bar as it gives the advantage of objectively rechecking the end point for vergence based on the deviation of one of the eyes during testing. For both near and far, the Negative fusional vergence (NFV) will be measured first followed by Positive fusional vergence to avoid influence of convergence testing on vergence recovery. Vertical row of letter of 6/9 Snellen equivalent will be used as the test stimuli and the prisms would be gradually increased in front of one eye until the subject reports diplopia (fusional vergence break) and then the amount of prisms are reduced until binocular single vision is restored (fusional recovery). The vergence testing will be done in free space without any chin rest or head support to mimic the natural testing conditions in the clinical set-up.

Apart from fusional vergence amplitudes, testing for vergence facility improves the sensitivity of diagnosis of binocular vision
anomalies. Vergence facility testing assess the dynamics of the fusional vergence system and a 12 Base out/3 Base in prisms combination has been found to differentiate the symptomatic from the normal BV group. The flip prisms combination will be flipped from Base in to out and the subject will be asked to keep the vertical row of 6/9 letters clear and single. A practice session for 30 seconds is provided before the test is begun. One round of Base out and Base in will be counted as one cycle and the number of cycles per minute will be noted down. While the test is being done, the simultaneous vergence movement of the eyes will be noted down to ensure bifixation. If the bifixation movement is not noted along with nil appreciation of diplopia during testing, suppression is indicated and will be noted down.

Tests for Accommodation

The Near Point of Accommodation (NPA) is the most important parameter used in the diagnosis of accommodative anomalies. With respect to the measurements techniques, push-up technique, has been considered as a standard due to its robustness, where the near target equal to or one line better than the best corrected near visual acuity is moved closer to the eyes until a sustained blur is noted. The readings in metrics are converted to Diopters to arrive at the Near point of accommodation. Though this technique has problems of varying magnification of the target due to proximity, it has still been followed routinely in the clinical set-up. A modification suggested by Scheiman & Wick (2008) to overcome this limitation include decreasing the near target size as it is taken closer to the patient’s eyes. Because of the simplicity of administration and its use in the clinical set-up, the push-up test will be adopted for the study.

The near point card with 6/6 snellen equivalent word will be used as the target and will be brought closer to the right eye until the subject reports sustained blur. The Astron International rule centred on the forehead was used to measure the endpoint of blur. The test will be repeated binocularly; two measurements will be taken for both eye and the average of the two readings will be noted down in centimetres and then converted to its Dioptric equivalent.

Accommodative response refers to the response of the visual system to an accommodative stimulus and the difference between the stimulus and response is termed as lag or lead of accommodation. Physiologically, the response is less than the stimulus which is a purposeful error due to the depth of focus and steady state accommodation properties of the eye, and the numerical value of the response is on the positive side defined as the lag of accommodation. If the response equals the stimulus, the numerical value of the response is zero; and if the accommodative response exceeds the stimulus, the numerical value is on the negative side defined as lead of accommodation. There are different techniques to estimate the accommodative response that include manual techniques such as Monocular Estimate Method (MEM) retinoscopy, Nott Retinoscopy and automated techniques such as using Open field autorefractor and Power refractor. MEM and Nott retinoscopy findings are comparable and less variable than the autorefractor accommodative responses. MEM retinoscopy is widely practiced in the clinical setup due to its simplicity and ease to correlate with clinical findings.

The MEM retinoscopy will be performed on the right eye of all the subjects by quickly scanning across the horizontal meridian while the subject read the grade appropriate near reading material pasted on the retinoscope. As the child read the words aloud, appropriate lens powers will be quickly interposed until neutrality is observed. The lens powers used will be recorded accordingly.

Accommodative facility testing is gaining increasing evidence as a representation of the dynamics of the accommodative system. Plus and minus lenses of equal magnitude are interposed in front of the eyes and the visual system’s response to relax and stimulate accommodation
respectively are assessed. Reading material (Standard practice is the use of a word rock card consisting of letters of N10 and N8 font size) is used and the subject is asked to focus, keep the words clear and then read them as quickly as possible through plus and minus lenses alternately. The number of words read in one minute is noted down and the accommodative facility is calculated in cycles per minute where one cycle represents focusing through a plus and minus lens (accounting to two words for one cycle). Using +/-2.00 DS lenses at 40 cm is recommended for children to differentiate between symptomatic and symptomatic individuals and use of amplitude scaled facility and suppression check are recommended as a standard testing approach in adults. In our study, a 20/40 font size for 7-10 years and 20/30 font size for greater than 10 years will be utilized and the letters are chosen from their grade text books to ensure that language difficulty does not influence the test results. 40 three letter words are chosen and the word rock grid has been made. While the procedure is done, the subject will be given a practice session for 30 seconds before beginning the test to ensure familiarity of the task and to minimize learning effect. Monocular accommodative facility will be assessed in the right eye for all the subjects followed by binocular accommodative facility. In the pilot study before methodology was decided, binocular accommodative facility was tested used the Bernell No.9 vectogram using a Polaroid glasses as suppression check. This target was found to be difficult to comprehend in our sample and hence the word rock card will be utilized for binocular testing in this study. If suppression is revealed in other testing, then the binocular accommodative facility will not be performed and will be noted down as suppression.

Repetition of Tests
NPC is done thrice, NPA is done twice, vergence amplitudes are measured twice, MEM lag once and the accommodative and vergence facility are measured once (after a practice session for 30 seconds) and the average is taken for analyses.

Phase III C: VR-QOL Assessment
The Convergence insufficiency symptom survey (CISS) questionnaire will be used to assess the severity of visual symptoms (15 items scored between 0 and 48 with greater scores indicating increasing symptoms associated with reading). The academic performance of each child would be obtained from their academic records and the Academic Behaviour survey (ABS) designed by Rouse et al (2009) will be administered to the respective class teachers to score the child on their academic performance. This is done to understand the impact of non-strabismic binocular vision anomalies on academic performance of children. It is agreed that the ABS is designed to be administered to parents, but in a population based study like this, getting the questionnaire filled from the parents back poses risk of losing the questionnaire by the child and also difficulty to track the child again to get the questionnaire back. The teachers as well cannot be burdened with this task of collecting the questionnaires back from the students for the same reason of loss of the questionnaire as mentioned above.

Phase III D & E: Diagnosis of NSBVA
The normative data obtained from the study will be used to provide cut-off for the generic criteria adopted for the classification of NSBVA. This generic criteria adopted for the diagnosis of NSBVA include conditions of convergence insufficiency, convergence excess, divergence insufficiency, divergence excess, basic esophoria, basic exophoria, accommodative insufficiency, accommodative excess, accommodative infacility and fusional vergence dysfunction. The prevalence of each specific type of NSBVA will be calculated. The cut-off for the generic criteria will be formulated after the normative data collection is over. Mean ± 1.00 SD will be used as the cut-off for the BV parameters.
Prevalence with the Minimum Test Battery

After the prevalence estimates are over, the ROC analyses will be performed to understand the minimum test battery needed to diagnose BV anomalies in a community set up.

After the ROC analyses, reassessment of prevalence will be carried out on 780 children chosen from a similar background as the phase 3 of the study. The prevalence estimates obtained from this phase will be compared with the earlier obtained prevalence to validate the minimum test battery.

Pilot Study to Determine Sample Size

Since there were no available data on prevalence of binocular vision anomalies in India, a pilot study was conducted on 100 children (15-18 years) in the urban location. The methodology for the pilot study was the same as the main study methodology detailed in the section below. The criteria and cut-off for the criteria for diagnosis of NSBVA was adopted from Scheiman & Wick, 2008. From the pilot study, the prevalence of symptomatic NSBVA was found to be 46%. Based on this estimate, the sample size was estimated to be 780 at 95% confidence interval and 5% precision with a design effect of 2 for cluster sampling. Considering a 20 percentage loss to follow-up with the intervention arm, the calculated sample size was 936. Another pilot study was carried out on 31 children in two schools and modifications in methodology were made regarding selection of tests based on the understanding and literacy levels of the children.

PRELIMINARY RESULTS

The prevalence of Non-strabismic binocular vision anomalies in the pilot study (n=100) was 46%. The classification of categories of NSBVA is listed below (Table 3). The most prevalent NSBVA was convergence insufficiency (32% in the overall population and 69.5% among the NSBVA) followed by accommodative infacility (10% in the overall population 21.7% among the NSBVA).

Data Management

Descriptive statistics will be calculated for all the binocular vision parameters in the different age groups. Appropriate statistical tests will be utilized to assess the developmental trend of the parameters among the various age groups. The prevalence of binocular vision anomalies and the normative data for the BV parameters will be estimated and Receiver Operating Characteristic curves will be plotted to find the most sensitive tests for BV anomalies. After the reassessment, the prevalence of BV anomalies will be estimated again.

CONCLUSION

This study will provide the prevalence data of binocular vision anomalies in rural and urban Tamilnadu and also provide normative data that can be used to differentiate the pediatric population with normal binocular vision from children with binocular vision anomalies. The study will also provide insight into the differences in binocular vision parameters between ethnicities, and the minimum battery of tests needed to detect binocular vision anomalies in a community setting.

REFERENCES

5. Maples WC. A comparison of visual abilities, race and socioeconomic factors as predictors of academic

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal BV</td>
<td>54</td>
</tr>
<tr>
<td>NSBVA</td>
<td>46</td>
</tr>
<tr>
<td>Convergence Insufficiency</td>
<td>32</td>
</tr>
<tr>
<td>Convergence excess</td>
<td>3</td>
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<tr>
<td>Divergence excess</td>
<td>1</td>
</tr>
<tr>
<td>Accommodative infacility</td>
<td>10</td>
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This is the generic criteria followed for the diagnosis of NSBVA. The quantitative details for the BV parameters will be fit into the criteria after the normative data is collected. These quantitative parameters include

1. Magnitude of distance and near phoria
2. NFV and PFV amplitudes for distance and near
3. Criteria for accommodative facility and vergence facility in cycles per minute
4. Lag of accommodation in MEM
5. Normative accommodative amplitudes (Mean +/-1.00 SD)

Any subject who fails more than 2 criteria will be diagnosed to have the specific anomaly.

**1. CONVERGENCE INSUFFICIENCY (CI)**

*Symptoms*: Associated with reading or other near tasks and generally worse at end of day. The most common symptoms include asthenopia and headaches, intermittent diplopia.

*Signs:*
1. Greater exophoria for near than distance
2. Receded NPC (near point of Convergence) break with accommodative target > 6 cm
3. Difficulty with Base out prisms/ Reduced PFV (Positive fusional vergence) (or) Failing Sheard’s Criteria (PFV less than twice the near phoria)
4. Difficulty clearing +2.00 DS with binocular accommodative facility

**2. DIVERGENCE INSUFFICIENCY (DI)**

*Symptoms*: Associated with distance viewing. The most common includes intermittent diplopia for distance, headache and eyestrain.

*Signs:*
1. Esophoria greater for distance than near, by any magnitude
2. Difficulty with base in prisms/ Low NFV (Negative fusional vergence) for distance
3. Difficulty clearing -2.00 DS with binocular accommodative facility

**3. CONVERGENCE EXCESS (CE)**

*Symptoms*: Associated with reading or other near tasks and generally worse at end of day. The most common includes asthenopia and headaches, intermittent diplopia.

*Signs:*
1. Esophoria greater at near than distance
2. Difficulty with base in prisms/ reduced negative fusional vergence at near
3. Difficulty with binocular accommodative facility with -2.00 DS
4. High MEM lag of accommodation

**4. DIVERGENCE EXCESS (DE)**

*Symptoms*: Associated with distance viewing than near. The most common includes intermittent diplopia for distance, headache and eyestrain.

*Signs:*
1. Intermittent to constant exo deviation for distance greater than near
2. Difficulty with Base out prisms/ Low PFV for distance
3. Difficulty clearing +2.00 DS with binocular accommodative facility

**5. FUSIONAL VERGENCE DYSFUNCTION (FVD)**

*Symptoms*: Associated with reading or other near tasks and generally worse at end of day. The most common symptoms include asthenopia and headaches, blurred vision and difficulty concentrating on near visual tasks.

*Signs:*
1. Reduced NFV and PFV for near and distance
2. Difficulty with both +/- 2.00 DS in binocular accommodative facility

6. BASIC ESOPHORIA
   Symptoms: Associated with reading or other near tasks and with distant activities. The most common near point complaints include eyestrain, headaches and blurred vision. Common symptoms associated with distance includes blurred vision and diplopia when watching television and in classroom.

   Signs:
   1. Equal amount of esophoria at distance and near
   2. Reduced negative fusional vergence at distance and near
   3. Difficulty with binocular accommodative facility with -2.00 DS

7. BASIC EXOPHORIA
   Symptoms: Associated with reading or other near tasks and with near and distant activities. The most common near point complaints include eyestrain, headaches and blurred vision.

   Signs:
   1. Equal amount of exophoria at distance and near
   2. Receded NPC with accommodative target
   3. Reduced PFV for both distance and near
   4. Difficulty clearing +2.00 DS with binocular accommodative facility

8. ACCOMMODATIVE INSUFFICIENCY (AI)
   Symptoms: Blurred near vision, discomfort and strain associated with near tasks, fatigue associated with near point tasks, difficulty with attention and concentration when reading.

   Signs:
   1. Reduced amplitude of accommodation compared to the expected normal amplitudes for age as per the normative data
   2. Blur at near point testing at Harmon’s distance
   3. Difficulty with monocular and binocular accommodative facility with - 2.00 DS
   4. High MEM lag of accommodation

9. ACCOMMODATIVE EXCESS (AE)
   Symptoms: Blurred distance vision worse after reading or other close work and often worse toward the end of the day, headaches and eyestrain after short periods of reading, difficulty focusing from far to near, sensitivity to light.

   Signs:
   1. Low MEM finding (lead of accommodation)
   2. Difficulty clearing +2.00 DS with monocular and binocular accommodative facility
   3. Presence or absence of near Esophoria

10. ACCOMMODATIVE INFACILITY (AIF)
    Symptoms: Blurred near vision, blurred distance vision after near visual tasks and vice versa, delayed focusing of objects, discomfort and strain associated with near tasks, fatigue associated with near tasks, difficulty with attention and concentration when reading.

    Signs:
    1. Difficulty with monocular/ binocular accommodative facility with +/- 2.00 DS
    2. Secondary reduction in fusional vergence amplitudes, both NFV and PFV
    3. Difficulty with both BO and BI prisms in Vergence facility testing
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