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Research Article

Repeated Testing of Vergence Facility and its Effect

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Abstract

Objectives: The study aimed to compare the effect of repeated testing of vergence facility, with the objective to find out the difference after repeated testing in symptomatic and asymptomatic subjects.

Method: 60 subjects of 11 to 30 years were included in the study & divided into symptomatic and asymptomatic groups according to Convergence insufficiency symptom survey questionnaire (CISS) and Vision Quality scale questionnaire survey (VQS). Refraction and tests for nonstrabismic binocular vision evaluation were done. The vergence facility was measured with the help of 12 Δ BO and 3 Δ BI and three repeated measures were taken. T-test and ANOVA test were done to compare the difference between groups. $p<5x10^{-2}$ were considered significant.

Results: Three repeated vergence facility measurements were found 9.317, 10.117 and 10.883 in the symptomatic group with p value $3.22x10^{-1}$. In the asymptomatic group, mean vergence facility repeated were found 13.983, 15.083 and 15.850 with p value $4x10^{-2}$.

Conclusion: There was no difference found, statistically or clinically on repetition of vergence facility in symptomatic as well as asymptomatic subjects.

Keywords: Vergence Facility; Binocular Vision; Non Strabismic Evaluation

Introduction

Non-strabismic binocular vision anomalies are highly prevalent among school children and the prevalence increases with age. With increasing near visual demands in the higher grades, these anomalies could significantly impact the reading efficiency of children. Convergence insufficiency has higher prevalence than other binocular anomalies. Evaluating binocular vision anomalies is important for eye heath also eventually affects their quality of life [1,2]. Thus, it is recommended that screening for anomalies of binocular vision should be integrated into the conventional vision screening protocol [2,3].

The evaluation of binocular vision involves several distinct steps including measurement of heterophoria and assessing AC/A ratio, tests to measure amplitude and facility of accommodation and convergence. Motor Fusion are described in terms of Fusional vergences being diagnosed by the amount of phoria for distance and near, vergence range and facility [4].

Vergence facility testing is designed to assess the dynamics of the fusional vergence system and the ability to respond over a period of time. This ability to make rapid repetitive changes over an extended period of time can be referred to as measure of stamina. With help of measuring vergence facility we can measure the ability of an individual to maintain vergence at a particular level and then to rapidly alter the level. Patients presenting with symptoms characteristic of binocular disorder and other testing do not reveal any problems, such patients may have normal vergence amplitudes but

defective vergence facility. Thus testing for vergence facility is important [4]. Flip prisms are commonly studied and recommended for vergence facility testing. An important distinction among different methods of evaluating fusional vergence is the assessment of vergence amplitude versus vergence facility. Smooth and step vergence testing are designed to assess the patient's vergence amplitude, whereas vergence facility testing measures vergence dynamics [4].

Measures of vergence facility testing assess patient's ability to change vergence without changing accommodation. The base out prism forces eyes to converge and thus patient is forced to employ their positive fusional reserves to restore bifoveal fixation following introduction of base out prism pair. No change in accommodation is needed and any change in accommodation accompanies positive fusional effort. It may blur the target. Similarly patient needs to employ their negative fusional reserve without relaxing accommodation to overcome presence of base in prisms [5].

Study by Grisham found a relationship between vergence dynamics and symptoms in subjects studied. His research indicated that vergence latency and vergence velocity are of diagnostic importance in a binocular evaluation. It is possible for a patient to have normal fusional vergence amplitudes and still have a problem in the area of facility or vergence dynamics [4,6].

Using only the traditional smooth vergence evaluation approach would fail to detect such a problem. Gall et al. found that the use of 3 Δ base-in/12 Δ base-out for vergence facility testing can differentiate symptomatic from non-symptomatic patients [7].

Another consideration in testing fusional vergence amplitude or facility is the issue of performance over time. The important question here is whether the patient is able to compensate for a given amount of prism over an extended period of time. Traditionally, fusional vergence amplitude is measured just once. Research suggests that this may not be sufficient. Rather, these tests should be repeated several times, and testing that probes facility and ability to respond over time should be incorporated into the evaluation [6,7].

The aim of the study was to compare the effect of repeated testing of vergence facility. The objective was to find out difference in vergence facility after repeated testing in case of symptomatic and asymptomatic subjects.

Method

This research was reviewed by an independent ethical review board and conforms with the principles and applicable guidelines for the protection of human subjects in biomedical research.

The study carried out is a prospective observational clinical study. Duration of the study was from May 2019 to December 2020. 60 Subjects were enrolled after obtaining oral consent. The inclusion criteria was: Subjects with age range 11 to 30 years of age, visual acuity 6/6 in both eyes for distance, near vision with N6 at 40 cm in each eye. The exclusion criteria was subjects not willing to participate in the study, subjects with manifest deviation in each eye for distance or near, subjects with ocular or systemic pathology.

Subjects were divided into symptomatic and asymptomatic groups according to the Convergence insufficiency symptom survey (CISS) and Vision quality scale questionnaire (VQS). CISS contains 15 questions, 5 possible answers to each, scored on Likert scale. VQS has 9 questions, 6 options, discriminates between patients with and without asthenopia, scoring converted to %, score <72% significant.

Detailed History was taken, objective and subjective & refraction were done. Cover test & Maddox rod test to find out and quantify the amount of phoria. MEM Retinoscopy was done to rule out lag of accommodation. Measurement of fusional vergences for distance and near were done. Relative accommodative measurements were done at 40cm. Accommodative amplitude was measured monocularly and binocularly with help of the pushup method. vergence amplitude was measured with the push up method. The accommodative facility was measured with flippers. Three measurements of the vergence facility were taken. 3ΔBO/ 12ΔBI was used. Base in and base-out prisms flipped in front of the subject's eye for one minute. Line target for fixation was used at 40cm. - 3ΔBI was placed in front of the subject's eye asked subject to clear it (see it as single) -once the subject cleared it quickly flip 12ΔBO and again asked the subject to clear. The number of cycles per minute was recorded. This test was repeated three times.

The normal values were considered according to Morgan's scale. An integrative analysis approach was used for diagnosing Nonstrabismic binocular vision anomalies. Data were analyzed with the help of Microsoft Excel version 2016 (16.0.6741.2048). Unpaired T. test was used to compare differences between groups. ANOVA sin-

gle factor analysis was done to find out the difference between the groups after repeated testing. $p < 5x10^{-2}$ was considered significant.

Results

Total 60 participants were included in the study with the age group of 11 to 30 years. The mean age of symptomatic participants was 20.9 ± 4.421. The mean age of asymptomatic participants was 20.07 ± 3.55.

Among the symptomatic group, 40% were male and 60 % were female subjects while in the asymptomatic group 63% were male and 37% were female subjects.

CISS questionnaire was used to differentiate symptomatic subjects from asymptomatic subjects. The mean CISS score of symptomatic subjects was found to be 31.46 ± 6.415. The mean CISS score of asymptomatic subjects was 8.233 ± 3.626. The CISS score range in symptomatic subjects was 24 to 51 and asymptomatic patients were 2 to 15.

To differentiate symptomatic subjects from asymptomatic subjects VQS questionnaire was also used. The mean score of symptomatic subjects was found to be 59.654 ± 9.614 and in asymptomatic subjects mean and standard deviation found was 81.041 ± 7.123. The range of VQS scores in symptomatic subjects was 37.25 to 72.54 % was and asymptomatic subjects were 72.54 to 92.11 %.

Mean refractive error in symptomatic subjects were RE -2.00 ± 0.880 and LE -0.200 ± 0.714 and asymptomatic subjects RE was -1.283 ± 2.192 and LE was -1.287 ± 2.091. Spherical Refractive error in symptomatic subjects ranged from RE -2.25 to +1.50D, LE -2.25 to +1.00D, and asymptomatic subjects RE and LE was -8.25 to 0.25D.

The range of phoria in symptomatic subjects at distance was 10 exophoria to 8 esophoria with a mean and standard deviation of -0.383 ± 3.134. Near phoria in symptomatic subjects was in the range of 10 exophoria to 4 esophoria with a mean and standard deviation of -0.833 ± 2.465. In the asymptomatic subjects, distance phoria ranged from 5 exophoria to 1 esophoria with a mean and standard deviation of - 0.317 ± 1.095. The near phoria in asymptomatic subjects was -0.050 ± 0.747 with a range of 3 exophoria to 2 esophoria.

In NPC measured with Push up method in symptomatic subjects, the mean break was found to be 9.33 ± 4.773 and recovery was 10.883 ± 14.930. In asymptomatic subjects mean break was 5.967 ± 1.889 and recovery was 7.33 ± 1.626.

The negative fusional vergence in the symptomatic subject at distance measurement was mean for break 9.567, recovery 7.33. In the distance of the asymptomatic subject, NFV measurement means break was 10.267, recovery 7.733.

The NFV near measurement in the symptomatic group, mean break was 11.467, recovery was 8.9. In the asymptomatic group, the mean break was 13.9, recovery was 11.43.

The measurement for positive fusional vergence at distance in symptomatic subjects, measurement break was 11.53, and recovery was 9.06. In the asymptomatic group, PFV distance means break was 14.7 and recovery was 12.

Positive fusional vergences measurement at near in symptomatic subjects mean break was 14.8 and recovery was 12.53. In asymptomatic subjects, PFV near measurement mean break was 20.3 and recovery was 16.8.

Vergence facility measurements were repeated three times. ANOVA test was done to compare the difference between repetition (Figure 1. Vergence facility measurement).

In symptomatic group vergence facility measurement, the mean

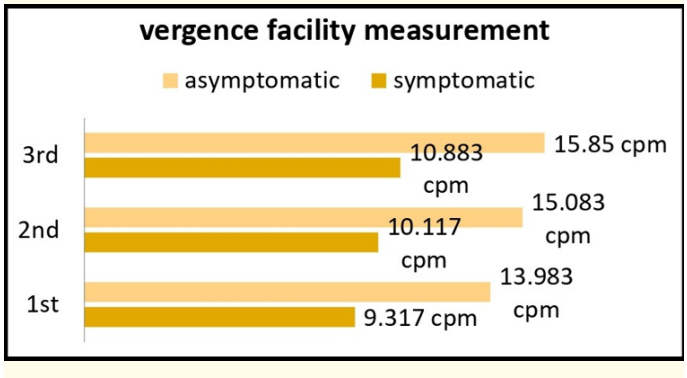

Figure 1: Vergence facility on repetition.

for the first measurement was 9.317, for second-time measurement was 10.117 and for third-time measurement was 10.883. On comparing the three groups, the p-value was found to be $3.22x10^{-1}$.

In the asymptomatic group, the mean vergence facility on first-time measurement was found 13.983, for second time 15.083, and for the third time 15.850. The p-value for the three groups' comparison was found $4x10^{-2}$.

The vergence facility measurements for both symptomatic and asymptomatic subjects showed that clinically there was a minor increase in vergence facility after each measurement. Statistically, there was no significant difference. However small increase observed in the values of repeated measurements might be due to vergence adaptation.

The Mean NRA in symptomatic subjects was 2.567 ± 0.598 and the asymptomatic subject was 2.958 ± 0.478. The Mean PRA in symptomatic subjects was -2.802 ± 1.272 and asymptomatic subjects -3.725 ± 1.121.

The accommodative facility for symptomatic subjects in the Right eye was 7.833 ± 5.158 Left eye 7.983 ± 5.040 and binocularly 7.70 ± 4.664. For asymptomatic subjects accommodative facility in the Right eye was 13.33 ± 3.061, the Left eye 14.15 ± 3.317, and the binocularly was14.20 ± 3.194.

The mean MEM retinoscopy findings in symptomatic subjects were 0.308 ± 0.540 with a range of -0.50 D to +1.75D and asymptomatic subjects were 0.517 ± 0.236 with a range of -0.25D to +1.00D.

With help of the Integrative analysis approach, binocular vision anomalies were diagnosed. Among the symptomatic population of 30 subjects, 10 were diagnosed with pseudo convergence insufficiency, 4 were diagnosed with accommodative excess,1 subject had accommodative excess associated with convergence insufficiency. 1 subject was diagnosed with accommodative infacility. 6 subjects were diagnosed with accommodative insufficiency, 1 with basic exophoria, 4 subjects had convergence insufficiency, 2 subjects had divergence excess type exophoria, 1 was diagnosed with poor NPC.

Discussion

30 subjects each in symptomatic & asymptomatic groups. A number of female participants were more in the symptomatic group. Thus maximum symptomatic subjects were of the school-going population.

A symptom score (percentage) of less than 71 on the VQS has been found to reliably suggest significant symptoms for patients older than 8 years [18]. In the present study, the VQS mean score of symptomatic participants was 59.65% and the asymptomatic group was 81.04%.

For children aged 9 to 17 years, a symptom score greater than 16 on the CISS has been found to suggest significant symptoms for adults (18 and older), a symptom score greater than 21 on the CISS has been found to be significant [19]. In the present study, the mean score of symptomatic participants with CISS was found 31.46 and that of asymptomatic was found 8.233.

Vergence facility measurements were done with help of 3 Δ BI and 12 Δ BO flippers. Three repetitive measurements were done.

Both in symptomatic and asymptomatic groups mean vergence facility was marginally higher with each measurement. In symptomatic groups, on comparing three measures, the p-value found was $3.2x10^{-1}$ and in the asymptomatic group, the p-value for comparing three repetitive measures was $4x10^{-2}$.

Clinical relevance of vergence facility was established by Ronal Gall., *et al*. [7]. They had used symptom-based questionnaire to differentiate symptomatic from asymptomatic subjects, while in our study we used CISS and VQS to differentiate groups. They found that 3 Δ BI and 12 Δ BO flippers differentiate optimally between symptomatic and asymptomatic groups at distance and near.

Thus our study included 3 Δ BI and 12 Δ BO flippers. According to Ronald Gall., *et al*. [7] a near vergence facility test is recommended as it is easily implemented, using a commonly available flip prism 3 Δ BI and 12 Δ BO and having a clinical failure criterion that is easily recalled 15 CPM. Our study showed similar results with symptomatic subjects showing vergence facility mean around 10 CPM in all three repeated measurements.

In the study 'Vergence facility and target type' by Ronald gall., *et al*. [8]. They found that vergence facility response was nearly independent of stimulus for three vertically oriented targets studied. It was found that unlike binocular accommodative facility needing vector graphic or anaglyphic suppression monitor, a simple and available target like a vertical row of 6/9 Snellen letters provides inherent fusional suppression clues for a valid binocular response. The same vertical row 6/9 target was used in the present study to measure the vergence facility. Gall., *et al*. studied, 'symptomatic patients with normal phorias at distance which test detects binocular vision problem?', [9] found that given a patient with asthenopia, normal phorias and visual acuity, a differential diagnosis may be made based primarily on using vergence facility and accommodative facility testing. They suggested that from a clinical standpoint, results expedite diagnosis of binocular vision anomalies and direct the treatment.

Momi-Moghaddham., *et al.* [16] in the study "Vergence facility with stereoscopic and nonstereoscopic targets", tested vergence facility in symptomatic and asymptomatic subjects with 3 Δ BI and 12 Δ BO flippers using nonstereo target, stereo local target, and stereo global target. In their study highest vergence facility was obtained with a nonstereo target and the lowest with the stereo global target. High sensitivity with all three targets suggested few false-negative results and high specificity indicated low false-positive results. Thus they concluded that vergence facility predictive value would be high in diagnosing binocular symptomatic patients using 3 Δ BI and 12 Δ BO flippers at near and cut off about 10 CPM or less. In our study Non-stereo (vertical target) was used and the mean score of symptomatic subjects was 9.31 CPM and asymptomatic subjects was 13.98. our results can be considered similar as symptomatic subjects with vergence facility less than 10 CPM.

Conclusion

There was no significant difference found in the repetition of vergence facility in symptomatic and asymptomatic subjects. The lack of difference might be due to vergence adaptation. Thus measurement of both vergence facility as well as vergence amplitudes is needed and only detecting vergence facility is not enough.

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