

A Comparative Study of Near Lateral Phoria of Young Adults Using the Von Graefe Technique and Maddox Wing

Azuamah Y. C.¹, Ukonu S. C.², Esenwah E. C.³, Ikoro N. C.⁴, Megwas A. U.⁵

¹⁻⁵Department of Optometry, Federal University of Technology, Owerri, Nigeria

Corresponding Author: Azuamah Y. C.

DOI: <https://doi.org/10.52403/ijrr.20220543>

ABSTRACT

Near lateral phoria is common among individuals and can lead to visual problems. It could be in the form of exophoria or esophoria. This study was a clinical study carried out at the Department of Optometry Teaching Clinic, Federal University of Technology, Owerri, Imo state, Nigeria. An informed consent was gotten from all the subjects who were part of the study. The near lateral phoria was measured using the von Graefe technique and was repeated using the Maddox wing. A total of 60 subjects between the ages of 18 and 30 years were used for this study. Out of this number, 49 (81.67%) has exophoria, 6 (10.00%) had esophoria, and 5 (8.33%) had orthophoria. Results showed that using the von Graefe technique, the mean exophoria value was 5.67 ± 2.77 and 4.37 ± 2.89 with the Maddox wing. Also, the mean esophoria value was 1.33 ± 0.82 with the von Graefe technique and 1.00 ± 0.00 with the Maddox wing. Data analysis with the SPSS version 23 data output using the Paired sample T-test at 0.05 level of significance and 95% confidence interval showed that there was a significant difference in near lateral phoria values ($P < 0.05$) between the von Graefe technique and the Maddox wing method of measuring near lateral phorias among young adults. Further research among other age groups was recommended.

Keywords: Exophoria, Esophoria, Orthophoria, Heterophoria, Near lateral phoria.

INTRODUCTION

Heterophoria is a latent deviation in which the eyes have a constant tendency to deviate and this occurs when one eye is covered. This deviation is overcome by muscular effort because of the strong desire to maintain binocular single vision. ^[1] A person with two normal eyes has single vision because of the combined use of the sensory and motor systems. The motor system acts to point both eyes at the target and any offset is dictated visually. Heterophoria only occurs during dissociation of the left and right eye, when fusion is absent. This tendency is identified by occurrence of an actual deviation in the absence of adequate stimulus to fusion, occurring in various designated forms according to relative direction or orientation of deviation. ^[2] When the eye deviates outward, it is termed exophoria and when the eye deviates inward, it is termed esophoria. When no deviation exists, it is termed orthophoria. Exophoria is a latent deviation outward from the line of sight while esophoria is an inward deviation from the line of sight. The expected value of near phoria is about 4 to 6^Δ (prism diopters) of exophoria ^[1], but it is not unusual for a patient's near phoria finding to be as high as 10 to 12^Δ of exophoria or 4 to 5^Δ of esophoria. At distance, the expected near phoria is 0 to ½^Δ exophoria. The tendency for asymptomatic individuals to have this moderate amount of exophoria at distance

and near is termed physiological exophoria.^[3]

The etiology of heterophoria has been attributed to three main categories^[4];

- (1) Anatomical factors which include; interpupillary abnormalities, abnormal strength or structure of the extraocular muscles, variation to the optical axis of the eye;
- (2) Physiological factors which include: Age; esophoria is more common in young age groups as compared to exophoria; Accommodation; increased accommodation leads to esophoria as seen in hypermetropia;
- (3) Neurogenic causes; lower motor neuron disease leads to incomitant heterophoria and upper motor neuron disease leads to comitant heterophoria.

Heterophoria and heterotropia have the same etiological factors. They are differentiated solely by patient's ability to overcome the deviation. Slight phoria is present in most normal individuals and is overcome by the fusion reflex. Heterophoria condition can be esophoria, where the eye tends to cross inward in the absence of fusion; exophoria in which they diverge, hyperphoria, in which one eye points up or down relative to the other.^[2] Heterophoria is usually asymptomatic. In severe cases, when the heterophoria is not overcome by fusion vergence, signs and symptoms appear, this is called decompensated heterophoria.^[5] When fusion is insufficient to control the imbalance, the phoria is described as decompensating and is often associated with symptoms of binocular discomfort, asthenopia (eyestrain), headache, photophobia (increased sensitivity to light), difficulty in changing focus from near to distance and vice versa, and double vision (diplopia).^[6]

Near lateral phoria is common among individuals, the most common being lateral deviation. It could be in the form of exophoria or esophoria and this can lead to visual problems. Patient usually experience occasional diplopia, severe headache with

vertigo.^[7] Symptoms are persistent and not relieved in spite of correction of refractive errors which may be associated with it. Eyestrain, asthenopia, diplopia, headaches are some of the symptoms experienced by people with lateral phorias. When the condition persists, it can lead to strabismus which is manifest deviation resulting from the paralysis.^[6]

Von Graefe technique is the most commonly used technique for measurement of lateral and vertical phorias. It employs a measuring prism over one eye and dissociating prism over the other eye. The tests are done under bright illumination at both far and near. The Maddox wing is an instrument utilized in the measurement of near phoria. It is a quantitative and subjective method of measuring the size of phoria deviation by dissociation of the eyes brought about by two septa which are placed in such a way as to present fields to either eye separated by a diaphragm at the center. The Maddox wing measures the size of the heterophoria and some of heterotropia at near when normal retinal correspondence is present. It is especially helpful when the patient present with symptoms of diplopia with no apparent cause.^[8]

MATERIALS AND METHODS

This study was a clinical study carried out at the Department of Optometry Teaching Clinic, Federal University of Technology, Owerri, Imo state, Nigeria. An informed consent was gotten from all the subjects who were part of the study. Ethical approval for this study was obtained from the Ethics Committee of the School of Health Technology, Federal University of Technology Owerri, Nigeria. The case history, ophthalmoscopy and external eye examination of the subjects were carried out to rule out people with ocular pathological conditions. The near lateral phoria was measured using the von Graefe technique and was repeated using the Maddox wing.

Procedure for Von Graefe Technique

The rotary prism on the phoropter was placed before the right eye and turned to 12^ΔBI (Base In) serving as the measuring prism. The prism on the left eye was turned to 6^ΔBU (Base Up) serving as the dissociating prism. To measure the lateral phoria at near, the patient focused at the best VA line on the reduced Snellen chart placed at 40cm. The prisms double the images of the chart, one above the other. The upper target was seen with the right eye and the lower with the left eye. The upper target was seen to the right of the lower target. On confirmation that the patient saw the two targets, the BI prism before the right eye was reduced gradually until the patient indicated vertical alignment of the upper and lower target. The amount of prism diopters remaining in the measuring prism was noted. Any BI prism remaining was recorded as prism diopter of exophoria. If the prism has crossed the zero mark into BO, it was recorded as prism diopters of esophoria. If it was at the zero mark, it was orthophoria.

Procedure for Maddox Wing

The Maddox wing test was performed at near with the instrument held in the reading position, slightly inferior (approximately 15-degree depression and 33cm away). The patient was instructed to hold the Maddox wing and identify the number that the white and red arrows point to on their respective scales. The patient held the Maddox wing up to his eyes and looked into the eye piece as if reading a book. The patient was asked if the arrow was pointing at a number or in-between two numbers. The subject's answer was noted and recorded. Only odd numbers show on one side of the scale and even numbers on the other. The white arrow on the X-Axis measured for lateral deviations in which, odd numbers represent an "eso" deviation and even numbers represent an "exo" deviation. In the absence of any deviation, both red and white arrows point to zero, indicating orthophoria.

Statistical Methods

The data obtained from the study was uploaded into the Statistical Package for Social Sciences (SPSS) version 23 software. The Paired-Sample T test was used to test the hypothesis at 0.05 level of significance and 95% confidence interval.

RESULTS

A total of 60 subjects between the ages of 18 and 30 years were used for this study. Figure 1 showed the distribution of phoria status of subjects. Exophoria had a frequency of 49 subjects and percentage of 81.67%, esophoria was 6 and a percentage of 10.00% while orthophoria had a frequency of 5 and a percentage 8.33%. Table 1 showed that using the von Graefe technique, exophoria of 1-4^Δ had a frequency of 18 and a percentage of 30.00%; 5-8^Δ exophoria was 24 and a percentage of 40.00%; 9-12^Δ exophoria was 7 and a percentage 11.67%. The table 1 also showed that 1-4^Δ esophoria had a frequency of 6 subjects and a percentage of 10.00%, 5-8^Δ and 9-12^Δ had a frequency of 0 and a percentage of 0.00%. Table 2 showed that using the Maddox wing, exophoria of 1-4^Δ had a frequency of 30 and a percentage of 50.00%; 5-8^Δ exophoria was 15 and a percentage of 25.00%, 9-12^Δ exophoria was 2 and a percentage of 3.33%; 13-15^Δ exophoria was also 2 and a percentage of 3.33%. The table also showed that 1-4^Δ esophoria had a frequency of 6 subjects and a percentage of 10.00%; 5-8^Δ, 9-12^Δ, and 13-15^Δ had a frequency of 0 and a percentage of 0.00%.

Table 3 showed that the frequency of subjects with orthophoria using von graefe technique and Maddox wing was 5 and a percentage of 8.33%. Table 4 showed that using the von Graefe technique, the number of subjects with exophoria was 49, the maximum value was 12.00^Δ, the minimum value 1.00^Δ, the mean was 5.67^Δ and the standard deviation is 2.77^Δ. Using the Maddox wing, the number of subjects were 49, the maximum value was 13.00^Δ, the minimum value was 1.00^Δ, the mean was

4.37^Δ and the standard deviation was 2.89^Δ. Table 5 showed that using von Graefe technique, the number of subjects with esophoria was 6, the minimum value was 1.00^Δ, the maximum value was 3.00^Δ, the mean was 1.33^Δ and the standard deviation was 0.82^Δ. Using the Maddox wing, the number of subjects was 6, the minimum value 1.00^Δ, the maximum value was 1.00^Δ, the mean was 1.00 and the standard deviation was 0.00. Data analysis with the SPSS version 23 data output using the Paired sample T-test at 0.05 level of significance and 95% confidence interval showed that there was a significant difference in near lateral phoria values [P(0.01) < 0.05] between the von Graefe technique and the Maddox Wing method of measuring near lateral phorias.

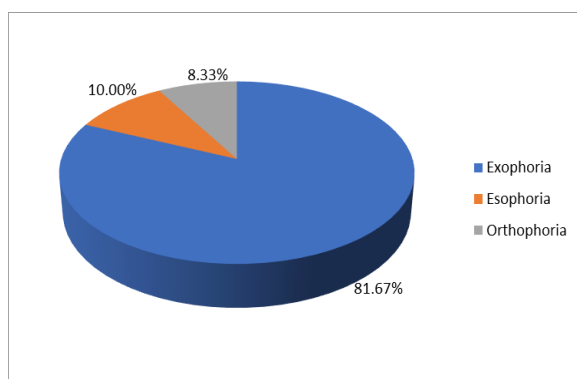


Figure 1: Distribution of near lateral phoria

Table 1: Distribution of near exophoria and esophoria values using Von Graefe Technique

Phoria (^Δ)	Exophoria		Esophoria	
	n	%	n	%
1-4	18	30.00	6	10.00
5-8	24	40.00	0	0.00
9-12	7	11.67	0	0.00
TOTAL	49	81.67	6	10.00

Table 2: Distribution of near exophoria and esophoria values using Maddox Wing

Phoria (^Δ)	Exophoria		Esophoria	
	n	%	n	%
1-4	30	50.00	6	10.00
5-8	15	25.00	0	0.00
9-12	2	3.33	0	0.00
13-15	2	3.33	0	0.00
TOTAL	49	81.67	6	10.00

Table 3: Distribution of near orthophoria values with Von Graefe Technique and Maddox Wing

Phoria Method	n	%
Von Graefe Technique	5	8.33
Maddox Wing	5	8.33

Table 4: Descriptive statistics of near exophoria values

Phoria Method	n	Range	Max	Min	Mean	S.D
Von Graefe	49	11.00	12.00	1.00	5.67	2.77
Maddox Wing	49	12.00	13.00	1.00	4.37	2.89

n = number; Min = Minimum; Max = Maximum; S.D = Standard Deviation

Table 5: Descriptive statistics of near esophoria values

Phoria Method	n	Range	Max	Min	Mean	S.D
Von Graefe	6	2.00	3.00	1.00	1.33	.82
Maddox Wing	6	0.00	1.00	1.00	1.00	0.00

n = number; Min = Minimum; Max = Maximum; S.D = Standard Deviation

DISCUSSION

Lateral phoria is an error of binocular alignment that manifest only during monocular viewing conditions or conditions that disrupt binocular vision. There are several methods in which near lateral phoria can be measured. This study compared the near lateral phoria using Von Graefe technique and Maddox Wing. Exophoria was found to be the most common with a percentage of 81.67% followed by esophoria with 10.00%. From this study, there was a significant difference in the lateral phoria values obtained from Von Graefe technique and Maddox wing with mean exophoria values being 5.67±2.77 and 4.37±2.89 respectively. The mean esophoria values were 1.33±0.82 and 1.00±0.00 respectively. Thus, phoria values with von graefe technique and Maddox wing were not the same. This is similar to the work carried out by Justin et al. [9] who compared the von Graefe technique with the Maddox rod for distance phoria and also found a significant difference. Oman et al. [10] studied heterophoria in children and reported a mean of 2.50±3.97 exophoria for lateral phoria at near using the von Graefe technique. However, another study by Jody et al. [11] found the near horizontal phoria values to be 3.84±4.80. Many studies [12-14] have established that the von Graefe technique gave a more reliable result of phoria values. Phoria values can be influenced by many factors such as near work, refractive errors, accommodation-vergence anomalies and amplitude of accommodation. All these factors impact more when using the Maddox wing as stated by Dweyer [15] who did extensive studies

with the Maddox Wing. Jonathan et al.^[16] conducted a study to attempt to improve the reliability of the Maddox wing test for the measurement of horizontal heterophoria at near.

Low amplitude of accommodation serves as stimulus in exerting accommodation effort. This effort will influence convergence resulting in excessive esophoria. Changes in the phoria could be potentially due to the amount of near work the person is subjected to. Therefore, phoria can be altered depending on the far and near sustained fixation position. When heterophoria tests are repeated several times under apparently equal conditions, the results obtained in the test will vary. This difference maybe not always be in respect to the magnitude of the phoria but also the kind of existing phoria. This may be the reason why a subject will be exophoric during von Graefe phoria test and esophoric during Maddox wing test. Kriz and Skorkovska^[17] reported variations in phoria measurements at different time intervals using the Maddox Wing. The difference in the testing distance of Von Graefe (40cm) and the Maddox wing (33cm) phoria test may explain the variation in the phoria results obtained. Lateral imbalance usually differs at various fixation distances and this is due to the fact that convergence demand changes with fixation distance. Hence, one may be orthophoric at far and either esophoric or exophoric at near depending on the visual mechanism of the individual. ^[6] Gross et al.^[18] found the modified Thorington test and Howell phoria card to be more repeatable than Von Graefe phoria test. Celia et al.^[19] confirmed that most subjective methods of measuring phoria have limitations that makes them unreliable. The degree and duration of dissociation and the stimulus to accommodation may vary, therefore producing different test results for the different techniques or methods used.

CONCLUSION

In conclusion, the mean exophoria and esophoria values among young adults

using the Von Graefe technique was significantly different from that of the Maddox wing test. This study showed a significant difference in near lateral phoria values using the Von Graefe and Maddox wing. Further research was advocated among other age groups.

Acknowledgement: None

Conflict of Interest: None

Source of Funding: None

REFERENCES

1. Grosvenor T. Primary Care Optometry. 5th ed. Newton: Butterworth Heinemann. 2007; 130-178.
2. Cuiffreda KJ. The scientific basis and efficacy of Optometric Vision Therapy in non-strabismic accommodative and vergence disorders. *Optom.* 2002; 73: 735-62.
3. Borish WJ. Clinical refraction. 2nd ed. Newton: Butterworth Heinemann. 2006; 290.
4. David AG. Current eye and vision science literature. *J Optom Vis Dev.* 2010; 42(4): 34-37.
5. David AG, Jennifer LR, Rebekah ET. Comparison of four dissociated phoria test, reliability and correlation with symptoms survey score. *J Behav Optom.* 2015; 21(4): 99-104.
6. Elliot DB. Clinical Procedures in Primary Eye Care. 3rd ed. Newton: Butterworth Heinemann. 2007; 229-230.
7. Khurana AK. Comprehensive Ophthalmology. 5th ed. New Delhi: New Age International publishers. 2012; 190.
8. Millodot M. Heterophoria. *Dictionary of Optometry and Visual Science.* 7th ed. London: Butterworth Heinemann. 2009; 491-6.
9. Justin M, Bethany M, Andrew H. Accuracy of double Maddox rod testing with variable prism induced hypertropia. *Invest Ophthalmol Vis Sci.* 2014; 54(15) 36-50.
10. Oman J, Neethu G, Abraham O, Krithica S. Normative data for near point of convergence, accommodation and phoria. *J Ophthalmol,* 2015; 8(1):14-18.
11. Jody F, Elaine C, Ian G, Kathryn R. Prevalence of heterophoria and associations with refractive error, heterotropia and

- ethnicity in Australian school children. *Brit J Ophthalmol*, 2009; 94(5): 542-546.
12. Screeniasan V. Effect of heterophorian type and myopia on accommodative and vergence responses during sustained near activity in children. *J Vis Res*. 2012; 64(4): 645-648.
 13. Paloma AC, Puell MC, Sanchez-Ramos C, Villena C. Normal values of distance heterophoria and fusional vergence ranges and effects of age. *Clin Exp Ophthalmol*. 2016; 244(7): 821-824.
 14. Risovic DJ, Misailovic KR, Eric-Marinkovic JM, Kosanovic-jakovic NG, Milenkovic SM, Petrovic LZ. Lateral Phoria measurements in a population of university students. *Eur J Ophthalmol*. 2018; 17(8): 326-331.
 15. Dweyer P. A comparison of near phoria and measurement by the Maddox wing and the keystone telebinocular stereoscope. *J Clin Exp Opt*. 2000; 64(1): 20-21
 16. Jonathan SP. An enhancement to the Maddox wing test for the reliable measurement of horizontal heterophoria. *Ophthalmol and Physiol Opt*. 2005; 25(5): 445-51.
 17. Kriz P, Skorkovska S. Distance associated heterophoria measured with polarized cross test of MKH method and its relationship to refractive error and age. *Clin Optom*. 2017; 35(13): 701-708.
 18. Gross B, David A, Grosvenor T. Reliability and comparison among methods of ensuring dissociated phoria. *J Optom Vis Sci*. 2006; 73(6): 389-397.
 19. Celia RG, David T, Kathryn R. Accommodation and phoria in children wearing multifocal contact lenses. *J Optom Vis Sci*. 2018; 1(1): 265-277.

How to cite this article: Azuamah Y. C., Ukou S. C., Esenwah E. C. et.al. A comparative study of near lateral phoria of young adults using the von Graefe technique and Maddox wing. *International Journal of Research and Review*. 2022; 9(5): 367-372. DOI: <https://doi.org/10.52403/ijrr.20220543>
