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Measuring the AC/A Ratio with Heterophoria Method and Gradient Method

Maram Abdul AAA*

Faculty of optometry, AL Neelain University, Contact lens Department, Khartoum, Sudan

***Corresponding author:** Maram Abdul AAA, Faculty of optometry, AL Neelain University, Khartoum-Sudan; E-mail: www.maroom7788@gmail.com

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Abstract

Purpose: To find is their difference on AC/A ratio amount between heterophoria method, distance gradient with concave lens method and near gradient with convex lens method with respect to gender and age.

Method: Data was collected on 50 myopic subject (10 males,40 females), there ages were from 17-28 years old subdivided to three group ages. All subjects had near and distance vision tested along with an orthoptics examination. Near heterophoria, near with convex lenses heterophoria, distance heterophoria and distance with concave lenses heterophoria were measured. the AC/A ratios by heterophoria method considering to IPD measurement, gradient method with convex lenses for near and gradient with concave lenses for distance were measured. The data were analyzed using the Wilcoxon Signed Rank test to investigate the significant different between heterophoria method, gradient with convex lenses for near and gradient with concave lenses for distance.

Result: Mean (±SD) AC/A ratio for near gradient was (2.24±0.29), distance gradient was (1.50±0.32) and heterophoria method was (5.96±0.58). The heterophoria method tended to give a higher value than gradient method and the near gradient method gave a higher value than distance gradient method. comparison of all methods with Wilcoxon signed rank test showed that there was a statistically significant difference between the methods($P<0.001$). the AC/A ratio did not differ between genders and no significant association between ages.

Conclusion: From this result there is significant different on measuring AC/A ratio between heterophoria method, distance gradient method with concave lens and near gradient method with convex lens; so, we should use all method when measured it.

Keywords: AC/A ratio; Gradient method; Heterophoria method

Introduction

The accommodative convergence/accommodation (AC/A) ratio is amount of accommodative convergence that occurs for each diopter of change in accommodation [1]. There are two types of AC/A ratio; stimulus and response AC/A ratio [2]. Response of AC/A ratio was highest in myopia, intermediate in emmetrope, and lowest in hypermetropes. The stimulus AC/A ratio did not vary with refractive error. The response AC/A ratio has been found to be higher than the stimulus ratio [3]. the response AC/A ratio did not change as a function of age [4]. The effect of age on the ratio is slight [5]. The ratio is general believed to be inborn and the remain constant throughout life. AC/A ratio were almost constant with age of 38 years; it then gradually increased till the age and then it decreased [6]. Some studies observe a gradual decrease of the ratio after the age of 25 years [7]. The stimulus AC/A ratio is used clinically to investigate and manage anomalies of binocular vision [2,4,8]. The AC/A ratio may be different at distance and near [9,10], but is little affected by the length of period of dissociation [11] or by previous adaptation to prisms [12]. There are several ways to measure AC/A ratio. Clinically, there are three methods used to determine the AC/A ratio: the gradient, fixation disparity and calculated heterophoria methods. Previous studies have established the gradient method to be most accurate [13]. The difference between the gradient and heterophoria methods has been found [14,15]. Clinically, we should use both plus and minus lenses while measuring AC/A ratios with the gradient method rather than a single lens type [16].

the normal AC/A ratio is about 3 to 5 prism dioptres for one dioptre of accommodation. actually, in clinical use that is not single normal value of AC/A ratio it must viewed in relation to method used to measure it, AC/A ratio in gradient methods by use both plus and minus lens is 2:1[17]. AC/A ratio founded for near gradient, distance gradient, gradient using synoptophore and heterophoria methods were 2.0, 1.0 ,1.0 ,5.0, respectively [18]. The heterophoria method usually gives a higher value of the AC/A ratio comparison to the gradient method, since the awareness of the proximity of the near target will increase the convergence at near (proximal convergence). in the gradient method there is no change in the proximal cue. Add-on heterophoria method take IPD in their calculation, the wider the IPD the grater the convergence necessary and vice versa [19]. Lee SY observe Different AC/A ratio values were obtained using three different methods. Among the three methods, the Heterophoria method tended to give a higher value than the gradient method, and the near gradient method tended to give a higher value than the distance gradient method [20]. C. Murray; D. New sham Comparison of all Gradient method with convex lenses (NG) and concave lenses (DG), the Gradient with the Synoptophore (SG), Maddox wing and the Heterophoria (H) method showed that there was a statistically significant difference between the methods [16]. Harsha Bhoola, Adrian S. Bruce and David A. Atchison compared heterophoria and gradient methods. they observed the heterophoria method give higher value than gradient method [21]. Chiranjib Majumder and Revathi Mutusamy recommend clinically, we should use both plus and minus lenses while measuring the AC/A ratio with the gradient method rather than a single lens type [15].

Methodology

cross-sectional study included 50 myopic subjects. Written informed consent was obtained from all the subjects who were included in the study. Subjects who had spherical myopia from at least –0.75 DS to -6 of both eyes and anisometropia ≤2.00 DS were included in this study. All subjects with squint, convergence anomalies, accommodation anomalies and ocular pathology were excluded. Relevant demographic data were obtained. All subjects underwent a thorough optometry examination. The Snellen E chart was used to measure distance vision. Objective refraction was measured with Auto Kerato-Refractometer (AKR) (TOPOCON, KR8900, POWER75 VA, JAPAN). Three readings were taken for each eye and averaged was used. The results were refined subjectively using Snellen's E chart and trial set of lenses. near chart was used to measure near visual acuity. For Heterophoria method, near phoria was measured by Maddox wing, distance horizontal phoria was measured by prism bar and cover test. IPD was measured by ruler. These values were used for calculation of AC/A ratio according to Heterophoria method equivalent. For near gradient method with convex lenses, first near heterophoria was measured with Maddox wing with subject was wore best distance correction. Second +3.00Ds lenses were placed in front of the Maddox wing and new phoria was noted. These values were used for calculation of AC/A ratio according to Gradient method equivalent. In distance gradient method with concave lenses, after subject wore had correction the distance phoria was measured by prism bar and cover test. -3.00Ds lenses were added and new phoria was reported. Gradient equivalent was used to calculation of AC/A ratio. Data analysis was carried out by using SPSS 16.0 software. The normality of the data was checked by using the Shapiro-Wilk test. The Wilcoxon signed rank test was used to assess the significance of the AC/A ratio. The Mann-Whitney test was also performed to determine the correlation between AC/A ratio and gender. The Kruskal-Wallis Test was performed to find the correlation between AC/A ratio and age by used three age groups.

Heterophoria method equivalent to calculate AC/A ratio:

AC/A=IPD+(Δn-Δd)/d, Where

IPD= interpupillary distance in centimeters

Δn= Deviation at 33 cm or 3 diopters

Δd=Deviation at 6 meters distance in prism diopters

d= the fixation distance at near in diopters

Gradient method equivalent to calculate AC/A ratio:

AC/A=(ΔL-ΔO)/D, where

ΔL= Deviation with additional lenses.

ΔO= Original deviation without additional lenses.

D = Dioptric power of the additional lenses.

Results

Fifty subjects were including in the study;(10) 20% males and (40) 80% females, their ages ranged between (17-28) with a mean of 21.54 ± 2.99 years. The near gradient method with +3.00D lens showed a mean AC/A ratio of 2.24±0.29 ranging from 2 to 2.60; the distance gradient method with -3.00D lens showed a mean ratio of 1.50±0.32 ranging from 0.66 to 2; and the heterophoria method showed a mean ratio of 5.96±0.58 ranging from 4.47 to 7.00 D. The heterophoria method tended to give a higher value than the gradient method, and the near gradient method gave a higher value than distance gradient method. Comparison of all method with Wilcoxon signed rank test showed that there was a statistically significant difference between the methods $P<0.001$. the difference was between +3.00 D lens and -3.00D lens ($p<0.001$), +3.00D lens and heterophoria ($p<0.001$) and -3.00D lens and heterophoria($p<0.001$). there was no significant difference in the AC/A ratio between the sexes as shown in table2. Subjects were categorized into three subgroups based on age: 17-20, 21-24, and 25-28 years No significant association was established for age group with AC/A ratio as shown in Table 3.

***Table 1**: Comparison of AC/A ratio using gradient at near, gradient at distance and heterophoria methods.*

AC/A ratio	+3.00	-3.00	hetrophoria	+3.00	hetrophoria	-3.00
Mean ± sd	2.24 ± 0.29	1.50 ± 0.32	5.96 ± 0.58	-	-	-
p-value	<0.001		<0.001		<0.001	

***Table 2:** Comparison AC/A ratio between Genders.*

AC/A ratio	Gender	Mean ± sd	p-value
+3.00	Male	2.36 ± 0.30	0.153
	Female	2.21 ± 0.28	
-3.00	Male	1.59 ± 0.34	0.315
	Female	1.48 ± 0.32	
Heterophoria	Male	6.22 ± 0.56	0.551
	Female	5.92 ± 0.61	

***Table 3:** Association between AC/A ratio and Age Group.*

Age group	AC/A ratio					
	+3.00 Mean ± sd	p-value	-3.00 mean ± sd	p-value	heterophoria Mean±sd	p-value
17-20	2.27 ± 0.30	0.539	1.54 ± 0.31	0.157	5.87 ± 0.55	0.386
21-24	2.02 ± 0.44		1.44 ± 0.34		6.01 ± 0.54	
25-28	2.30 ± 0.31		1.53 ± 0.32		6.05 ± 0.76	

Discussion

this study was to compare the gradient and heterophoria methods to measure AC/A ratio. Our target was to determine whether the use of gradient method or heterophoria method has same effect or if using both method is necessary in clinical practice. this study was showed that was significance difference in AC/A ratio when used heterophoria method and gradient method p<0.001, the studies done by Lee SY and C. Murray, D. Newasham agree with this result p<0.001. This study was found that a significant difference existed between the gradient AC/A ratio when using plus and minus lens power p<0.001. also, the study done by Chiranjib. M and Mutusamy. M was found that the gradient AC/A ratio with +3.00D lens was significant different from -3.00D lens p=0.002. The heterophoria method had been gave a higher value of the AC/A ratio comparison to the gradient method in this study. Ac/a ratio with +3.00 gave higher value than with -3.00 in gradient method. the means of AC/A by gradient method with +3.00D lens was 2.24:1 and with -3.00D lens was1.5 :1and by heterophoria method was 5.96:1. These results agree with results done by Lee SY, C. Murray; D. New sham and Harsha Bhoola, Adrian S. Bruce and David A. Atchison. The means of AC/A ratio by heterophoria method were 5.71:1, 5.96:1 and 5.81:1 respectively. And by gradient method were 3.36:1(NG) 1.79:1(DG), 2.86:1(NG) 1.22:1(DG) and 3.49:1 respectively. There was no significant difference in the AC/A ratio between gender in heterophoria, gradient with +3.00 and gradient with -3.00 methods p=0.551, 0.153, and 0.315 respectively. Study with Lee SY agree with this result. The current study did not show a significant difference in AC/A ratio between ages in heterophoria, gradient with +3.00 and gradient with -3.00 methods p=0.386, 0.539 and 0.157. Study with Lee SY agree with this result.

Conclusion

This study showed there was different in amount between gradient method and heterophoria method when measured AC/A ratio. It was necessary to use both methods clinically. Age and gender showed no special relationship with the measurement of AC/A ratio with both methods.

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