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Quick and Accurate Determination of Presbyopic Addition

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ABSTRACT

Background: Presbyopia is one of the common condition where the near point recede beyond the distance at which the individual is accustomed to read or to work, being unable to see clearly. It is the gradual loss of the eyes ability to focus on nearby objects. The use of plus lenses to compensate for the reduction in the range of accommodation associated with presbyopia, brings the near point of accommodation to a comfortable distance for near visual task. This study is done to estimate an ideal clinical methods of measuring near addition for presbyopic patients.

Material and Methods: Sixty healthy subjects with a mean age of 50 years were participatedin this study. Tentative near additions were determined usingnegative and positive relative accommodation (NRA & PRA), fused cross-cylinder (JCC) and Near Duochrome. The power of the addition was then refined to arrive at the final addition.

Result: There is no statistical significant difference between near duochrome and final addition power (0.03 ± 0.50) with p-value 0.584554 whereas there is statistical significant difference between NRA PRA (0.13 ± 0.55) with p-value 0.04105 and JCC (0.33 ± 0.46) with p-value <0.00001 and final addition power.

Conclusion: Average age of living in the world amongst humans are soaring day by day. The numbers of presbyopic people are also booming. Time as well as accuracy is a very important factor in current generation. Prescribing near addition is art for presbyopia which can be performed quickly and precisely by near duochrome test.

Key Words: Refractive error, Accommodation, Presbyopia, Near addition, NRA PRA, Near duochrome, Jackson Cross Cylinder

INTRODUCTION

The term Presbyopia (Greek = Presby = Old, opia = sight) means “old eye”. It is the gradual loss of the eyes ability to focus on nearby objects. People often confuse farsightedness with another condition called presbyopia. As people age, the internal lens of the eye becomes less elastic and incapable of focusing on near objects. Presbyopia is a natural process and affects nearly everyone over the age of 40, including those who’ve never worn glasses or contact lenses. This is different from nearsightedness (myopia), farsightedness (hyperopia) and astigmatism which are related to the shape of the eyeball.[1]

A comprehensive study estimates that 1.04 billion people in the world experience vision impairment caused by presbyopia. The study revealed that an estimated 517 million had either no eyeglasses or inappropriate eyeglasses. As a result their ability to complete important daily tasks is restricted. Most (386 million, or 94 percent) lived in the developing world.

The worldwide prevalence of presbyopia will increase to 1.4 billion people by 2020 and to 1.8 billion people by 2050. The global number of people who will suffer from a disability associated with uncorrected presbyopia is predicted to grow to 563 million people by 2020.

The International Centre for Eye care Education (ICEE), as a partner in VISION 2020: The Right to Sight, is working to help build sustainable eye care services throughout the world to eliminate avoidable blindness and vision impairment due to uncorrected refractive error by the year 2020.

This problem is corrected by increasing plus power for near with the aid of either readers, bifocals, trifocals or other types of multifocals including progressive addition lenses,

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or contact lenses in the form of multifocal contact lenses or monovision system.

The cause of presbyopia is the reduction in the ability of the eye to accommodate for near objects. This happens due to hardening of the crystalline lens. This condition usually occurs above 40 years of age.

People who become presbyopic may complain of headaches and eye strain, and hold objects progressively further away from their eyes in order to be able to focus on them.

People with this condition may experience eye fatigue or headaches when reading in poor lighting or at the end of the day. They may have trouble changing focus from distance to near, or they may feel the need to constantly reposition reading material in an attempt to find the right focus.

This condition affects people with good vision or near-sightedness, but is more problematic for those who are farsighted. Suddenly, after 40 years of living without vision correction, hyperopes often lose both distance and near vision at the same time because their eyes can't compensate any longer.[2]

This study was conducted to find an ideal clinical method of measuring near addition for presbyopic patients between age group of 40 to 60 years, to determine and compare the final addition power with different clinical methods i.e. NRA PRA, Near JCC and Near Duochrome.

MATERIALS AND METHODS

In this prospective study, sixty (60) healthy subjects with a mean age of 50 years (range 40 to 60 years) were included with best corrected visual acuity greater than or equal to 6/6 at distance. Equal number of participants were included where 30 were Male and 30 were Female.

The data collection tool used for the study were LogMAR Visual Acuity chart (distance), Ben Franklin Near Chart, Trial lens set, Trial frame, Retinoscope, JCC Cross, Near Duochrome and Scale.

The participants were explained about the study and made to sign a consent form if they want to be a part of the study. All the subjects based on inclusion and exclusion criteria were enrolled into the study after taking written informed consent. All the study related parameters were collected by principal investigator. The detail procedure of different tests are as below:

VISUAL ACUITY

Distance Visual Acuity: LogMAR ETDRS distance acuity chart kept at 4 meter apart from the patient and asked to read, gives the measurement of visual acuity for that patient. The distance between patient and the chart is gradually reduced looking at the comfort weather the chart is easy to move or the patient for those failing to read the chart at 4 meter. The value can be recorded in terms of logarithmic units.

REFRACTION

Patient is given a distance target i.e. largest letter size in the distance acuity chart and asked to look at it. The examiner scopes the right eye of the patient with his right eye and vice-versa maintaining distance of his arm length from the patient provided that illumination should not be more intense. The retinoscopic beam which comes from the fundus neutralizes by putting appropriate power on top of the trial frame. Both the meridians are similarly neutralized. The value which is obtained after neutralization is the gross value. The dioptric value of the arm length is reduced from the gross value, gives the net retinoscopy value. Then subjective acceptance was recorded.

There are different techniques to find near addition power for presbyopia. They are as listed below:-

- Dynamic retinoscopy
- Amplitude of accommodation (AA)
- Binocular fused cross-cylinder
- Near duochrome
- Balance of negative and positive relative accommodation (NRA, PRA)
- One-half amplitude accommodation with minus lenses (AAL)
- One-third accommodative demand with positive lens (ADL)

But, to perform all these tests, more time is required. The minimum time required including subjective refraction and near refinement will be 30 to 40 minutes. So, as epidemiology it is not possible to check all the presbyopic patients by few optometrists and ophthalmologists.

So, to reduce the fatigues and save the time, few tests was done in this study for the refinement of near addition power for presbyopic patients.

NPA (Near Point of Accommodation)

1. The patient wears his or her usual correction for distance
2. He or she is directed to a row of letters on the near card, which is one line larger than the better visual acuity.
3. The card is brought closer to the patient, until he or she reports a sustained blur.
4. The distance between the card and the spectacle plane is measured, and is called the near point of accommodation (NPA).
5. NPA is converted to its dioptric equivalent to give the amplitude of accommodation (AA).

TENTATIVE ADD

1. Calculate working distance in dioptric value.

2. Determine amplitude of accommodation (AA) 50% of its total value.
3. Determine tentative add by using formula 1/WD – ½ (AA).

NRA (Negative Relative Accommodation)

Patient with best correction for distance is given a target of one line above best corrected visual acuity at their working distance. Plus lenses are added in 0.25D steps until subject reports a sustained blur. The lenses are removed after placing the next lens. This value is recorded and the lenses are removed in 0.25D steps.

PRA (Positive Relative Accomodation)

Patient with best correction for distance is given a target of one line above best corrected visual acuity at their working distance. Minus lenses are added in 0.25D steps until subject reports a sustained blur. The lenses are removed before placing the next lens. This value is recorded and the lenses are removed in 0.25D steps.

1. Calculate the average of the sum of NRA and PRA.
2. Add this sum to the tentative add to get refined add.
3. Check the linear range of clear vision and change the refined add such that the patient's customary working distance falls at the centre of this linear range.

FUSED CROSS CYLINDER

This method was used to establish the point of accommodation for 40 cm working distance. The crossed cylinder (with the minus axis vertical) was positioned before both eyes. With the distance correction in place, plus lenses were added until the horizontal and vertical lines on the cross cylinder grid subjectively appeared equally clear.[3]

NEAR DUOCHROME

Near duochrome card was made manually (figure 1). Bernellred and green glass was used for the cancellation of the colour. A card with red and green background was presented at 40 cm. The duochrome test is based on the natural chromatic aberration of the eye and it can be used for determining the spherical components for distance and near.

For presbyopic patients, both red and green will focus behind the retina. Because the red light will focus further behind the retina than the green light, the presbyopic patient will see the letters on the green background as clearer. Then, plus lenses are added until the letters on the red background become as clear as on the green background.[3]

FINAL ADD

1. Fina add was determined by further refining it considering the patient's physical stature (increase add for a short person and decrease it for a tall person)
2. Visual acuity for both distance and near was checked.
3. Rechecking of distance and near refractions was done if they are not equal and comfortable.

Data was analysed using paired t-test for the statistical significance of various tests.[4] Balanced Incomplete Block Design (BIBD) calculation was used for the test to be performed on each participation.

Formula for t-test is as below:-

$$t = \frac{\bar{d}}{S_d / \sqrt{n}}$$

Where,

d = is the sample mean difference.

n = the number of sample differences

S_d= the standard deviation of the sample differences

RESULTS

The data of mean value of presbyopic corrections with power in diopters is provided in figure 2. The level of nearest value between each of the tests used to determine tentative addition in presbyopes and the final addition showed no statistical significant difference between Near Duochrome and final addition power.

Table 1shows comparison of all the tests, there is significant difference between NRA PRA and final addwith mean difference (0.13 ± 0.55) and p-value 0.04105. As p-value <0.05, we reject null hypothesis with 95% confidence level and accept alternate hypothesis. So NRA PRA is not close to that of final addition power.

There is significant difference between JCC and final add with mean difference (0.33 ± 0.46) and p-value <0.00001. We reject null hypothesis with 99% confidence and accept alternate hypothesisas p-value is <0.01. So JCC is not close to the final addition power.

There is no significant difference between near duochrome and final add with mean difference (0.03 ± 0.50) and p-value 0.584554. We accept null hypothesis with 95% confidence and reject alternate hypothesis as p-value <0.05. So JCC is not close to the final addition power. Near duochrome did not have any significant difference as that of JCC similarly as NRA and PRA.

DISCUSSION

The evaluation and management of presbyopia are important as functional deficits can occur when it is left untreated. Undercorrected or uncorrected presbyopia can cause visual

disability and have a negative impact on the patient's quality of life.[5]

To determine the addition power in the presbyopes is really an essential clinical test for evaluating patients over the age of 40 years.[6] The results of these tests are usually refined to achieve comfortable near task for the presbyopes. In this study, our aim was to find the best method of measuring near addition among three different methods (i.e. NRA PRA, JCC and Near Duochrome).

Our study demonstrates that Near Duochrome method and Final Addition in presbyopia is closer to each other. On the other hand, JCC and NRA PRA shows there is a significant difference from final addition power.

There are several other factors which relate to the conditions of each test like visual needs, work habits that could bring changes in the addition power. The additions established by the age-based method reveal that subjects of similar age may require different additions depending on their degree of ammetropia, although these differences diminish after the age of 44 years.

It is difficult to compare our results with those of other authors, as there are few investigations in which final additions are compared.

Hanlon, Nawakayashi and Shigezawa compared four procedures for establishing final addition power. These authors reported that tentative additions based on binocular cross cylinder, NRA PRA and AA measured by the push-up procedure was higher than the final addition, while the age-expected addition was closer to the definitive addition[6]. Similarly, our findings indicate that NRA PRA and JCC findings are higher than the final addition power.

White foot and Charlan compared the addition required at 33 cm determined by dynamic retinoscopy with the additions established from AA measurements, the duochrome test and subjective preference. These authors concluded that dynamic retinoscopy has limited value for indicating the appropriate near addition, as it significantly shows higher value.Though these authors found that the typical differences between dynamic retinoscopy-determined additions and the final additions are high, they did not compare these tests with the final addition. In our study we established the difference between the tests by comparing the findings of NRA PRA, JCC and Near Duochrome with the final addition power.

In this study, the aim was to determine an ideal clinical method of measuring near addition for presbyopic patients determined by three methods and the final addition. The results indicate that there is difference between NRA PRA and JCC findings and final additions and there is no difference between Near Duochrome and final addition power.

Our findings suggest that the method that provided the result closest to the final addition power was the Near Duochrome procedure. This test showed the closest value with the final addition power. Near Duochrome for assessing the near addition power is an easy and effective test and it takes no more time.

CONCLUSION

In this study, we concluded that among all the three methods (i.e. NRA PRA, JCC and Near Duochrome), Near Duochrome is closer to the final addition power. The findings of NRA PRA and JCC were found underestimating the final addition power.

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Table 1: Comparison of near addition with each clinical method to Final add

Null Hypothesis	Alternative Hypothesis	T-test	P-Value	Conclusion
NRA PRA = Final ADD	NRA PRA ≠ Final ADD	-2.0778	0.04105	NRA PRA ≠ Final ADD
JCC = Final ADD	JCC ≠ Final ADD	-6.464	<0.00001	JCC ≠ Final ADD
ND = Final ADD	ND ≠ Final ADD	-0.5497	0.584554	ND = Final ADD *

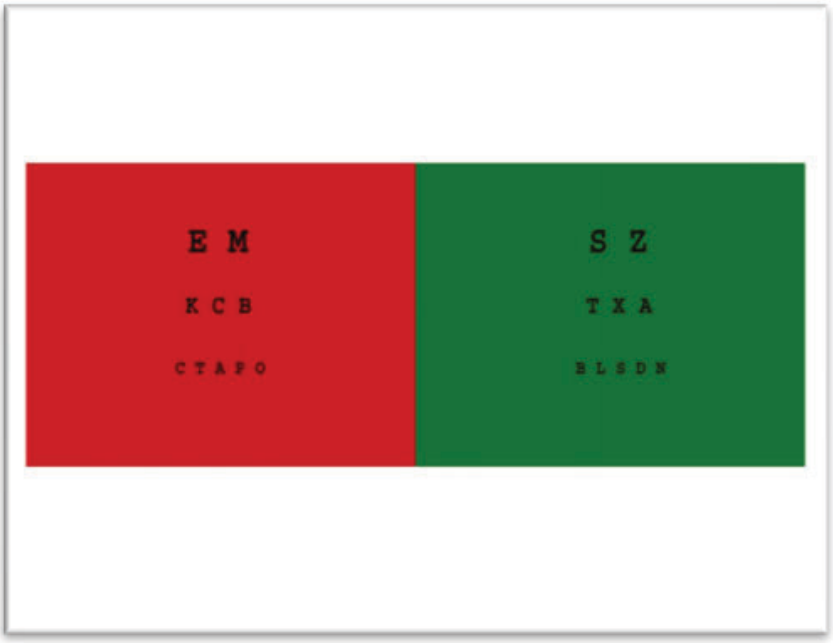

Figure 1: Near Duochrome chart.

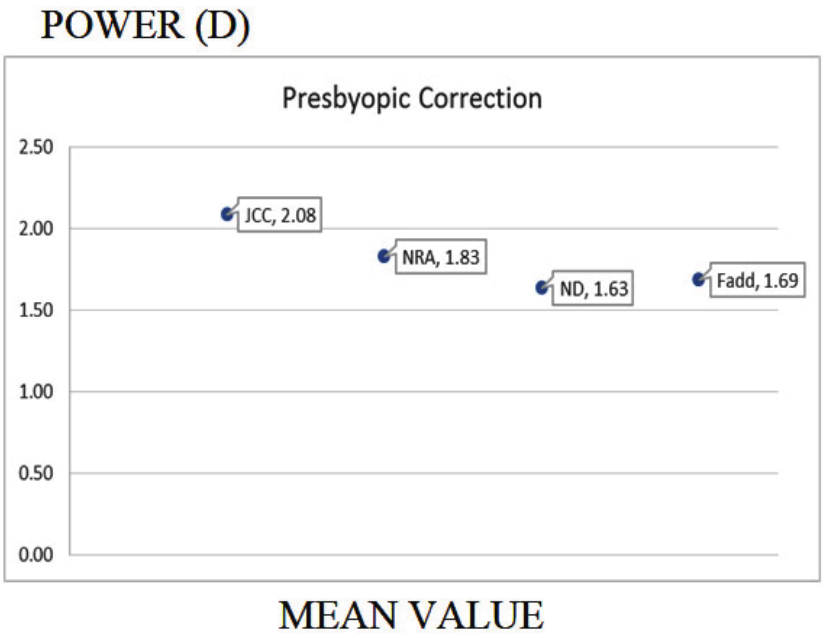

Figure 2: Mean value of presbyopic correction methods VS power in Diopter.