

Comparing Methods of Determining Addition in Presbyopes

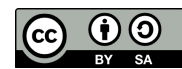
Arun Prasad Dhungana

Lecturer NAMS, Optometrist,
Nepal Eye Hospital,
Nepal.



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Abstract

Background: There are various method to determine the tentative near addition. The aim of the study is to compare the common methods of tentative near addition with final subjective acceptance.

Methods: The study is Cross sectional and analytical. Total 444 eyes of 222 patients with age group of 35-45 years are included in the study. Eligible patients are refracted and given the best distance correction. Near vision is tested and tentative near addition are determined using four different methods. We use dynamic retinoscopy, amplitude of accommodation, balance of NRA/PRA (Negative relative accommodation and positive relative accommodation) and age expected addition and compare the tentative addition determined with these methods with final subjective acceptance. Final addition is determined according to the patient's best subjective acceptance.

Results: The initial near binocular add is $+1.038 \pm 0.48$ D. Among the different methods of near add determination, dynamic retinoscopy give the closest value (bias = $+0.04$, P value = 0.052) to the final subjective acceptance whereas the addition based on age has the largest bias (bias = $+0.51$ D, P value = 0.0001).

Conclusion: Among the different methods of near addition, dynamic retinoscopy gives the closest value to the final subjective acceptance. All the techniques display similar result and provide a tentative addition close to the final addition but any tentative addition has to be adjusted according to the particular needs of each patient. It is more reasonable to use the method that provides the tentative addition closer to the final addition.

Keywords: Presbyopia, Near Addition, Accommodative Lag, Dynamic Retinoscopy, Amplitude of Accommodation

Introduction

Presbyopia, the age related loss of accommodation is the most common physiologic ocular change beyond the age of 40 years and is thought to cause universal near vision impairment with increasing

age¹. It is the leading visual defect and its incidence is increasing owing to a higher life expectancy, improved social and health conditions and to the consequent ageing of the population¹. Moreover, we should consider that the onset of presbyopia occurs at an extremely productive stage of life and its inadequate correction will compromise a person's work performance with the economic loss this entails. According to Hanlon, Nawakayashi and Shigezawa, an error in reading addition is one of the most common causes of patients' unhappiness with their new spectacles². Presbyopia is believed to have functional consequences primarily for those who use their near vision for reading and writing.

But little attention has been paid to presbyopia in the developing world where literacy rates are low. This view is evident by the World Health Organization vision 2020 refraction agenda places little emphasis on presbyopia. However, this notion has no scientific basis; anecdotal evidence suggests a need for good near vision even among those who are in the rural developing world who may need adequate near vision for many of the tasks they carry out in course of their daily lives.

Despite the recognized importance of correcting near vision impairment, there were no studies regarding the presbyopia in Nepal. Uncorrected near vision places a substantial burden on the individual and society. It can have a potential negative effect on career choices, ocular health and self-esteem. So, proper correction of presbyopia in time is very much essential for them. There are different methods of correction of presbyopia and selection of appropriate method is important to give proper correction according to age and occupation. This study has compared different methods of correction of presbyopia and has recommended the best method. To the best of our knowledge, no such type of study had been performed in Nepal till date.

Presbyopic Addition

Determining the addition required by presbyopes, in optometric practice, is a simple procedure. A tentative addition is established first and this is then adjusted to obtain the final addition. In the final adjustment, the physical characteristics and needs of the patient are taken into account. Several techniques have been described to establish tentative addition. Most clinicians select one or two of these procedures for routine use depending on their personal preferences. It is more reasonable to use the method that provides the tentative addition closer to the final addition.

Methods of Tentative Add Determination³

1. Dynamic retinoscopy
2. Amplitude of accommodation
3. Age expected addition
4. Fused cross cylinder with and without initial myopisation
5. Near duochrome test
6. Negative and positive relative accommodation balance (NRA/PRA)

Methodology

Research Design

It is a cross-sectional and analytical study.

Place of Study

The study is conducted at B P Koirala Lion's Center for Ophthalmic Studies.

Study Period

It is conducted for one year.

Inclusion Criteria

Emmetropic patients of age between 35 to 45 years.

Exclusion Criteria

- Any form of ocular pathology
- Patients with accommodative anomalies and binocular problems
- Patients with systemic diseases under any medications those are likely to have effects on accommodation, fusional vergence and ocular motility
- Patients not willing to participate

Sampling Method

Purposive sampling method.

Research Tools**A. Data Collection Tools**

- a. A proforma was prepared for data collection.

B. Statistical Tools

- a. Central tendency is measured with mean and median.
- b. Variation is measured with standard deviation and range.
- c. Level of significance is measured with paired t-test.

Patient Selection

The study population comprise of 222 patients attending the refraction unit of BPKLCOS who satisfied the inclusion criteria and gave their consent to participate after the nature of the study had been fully explained to them.

Patient History

Detail history regarding visual and ocular status, systemic problems, food habit and alcohol consumption were recorded. Any history of systemic and ocular medication that could affect accommodation, fusional vergence and ocular motility were noted. History regarding blurring of vision for distance and near, asthenopia and discomfort on reading in dim illumination were documented. Any problems associated with near works were enlisted.

Visual Acuity

Visual acuity for distance was measured using self illuminated Snellen's acuity drum with multiple Optotype and illiterate E chart. Near visual acuity was recorded at distance of 40 cm with ambient lighting.

Near Add Determination

Static retinoscopy was performed at the working distance of 50 cm using Heine streak retinoscope. Patients were given full prescription for distance prior to tentative near add determination. All the procedures used to determine tentative addition were performed in random order except the dynamic

retinoscopy which was always undertaken first to avoid the results of the subjective tests influencing this objective procedure. The final addition for a 40 cm working distance was established for each patient by adjusting the tentative addition obtained using one of the five methods selected randomly.

Dynamic retinoscopy

The best distance correction was placed in the trial frame and patient was instructed to try to keep clear a line of Optotype of visual acuity 0.8 M presented at 40 cm. The retinoscopy was conducted at 40 cm, adding plus lenses in front of the patients' eye until the neutral point was seen. The mean of the added plus lenses to the RE and LE was taken as the tentative addition.

Amplitude of Accommodation

This procedure assumes that the prescription of addition should not be more than one-half of the total amplitude of accommodation. In our study, the working distance was 40 cm, so the tentative addition was calculated as $2.50 \text{ D} - 1/2 \text{ AA}$ (where AA is the mean amplitude of accommodation.) To measure the AA, we used Duane's method (clear to blur method).

Age Expected Addition

Several authors have prepared tables indicating the correlation between ages and reading addition. We used a modified version of table proposed by Pointer because Pointers table is recent than other consulted tables⁴.

NRA/PRA

The tentative addition was determined as the lens that placed the accommodative demand in the middle range of relative addition. Total relative addition was determined by finding the range between the least plus (PRA) and the most plus (NRA).

Data Analysis

Once the data had been collected for the entire study population, they were analyzed using SPSS 14 computer software and Microsoft Excel statistics program. The mean, standard deviation and confidence interval were calculated as per requirement. The level of agreement between the different tentative addition tests and prescribed addition was estimated. The factors determined were the mean difference (bias), the standard deviation (SD), the coefficient of agreement ($\text{COA} = 1.96 \times \text{SD}$) and the limit of agreement at the 95% level ($\text{bias} \pm \text{COA}$). The t-test for pair samples was used to establish the significance of the differences. The level of significance was set at $p < 0.05$.

Results

Among the four different methods, addition based on dynamic retinoscopy give the closest value to final subjective acceptance. Whereas addition based on age expected addition give the least close value to the final subjective acceptance. Almost all methods give the close reading to the final addition.

Table 1: Comparison of Different Methods of Near Addition

Methods	Mean Add (D)	Std. Deviation
Add based on age	+0.519	0.432
Add based on amplitude of accommodation	+0.838	0.477

Add based on dynamic retinoscopy	+0.991	0.411
Final subjective acceptance	+1.038	0.485
Add based of NRA/PRA	+1.238	0.574

Table 2: Final Subjective Acceptance in Different Ages

Age of Patient in Years	Mean Add (D)	Std. Deviation
35	+0.413	0.410
36	+0.642	0.363
37	+0.645	0.432
38	+0.726	0.394
39	+0.736	0.444
40	+1.068	0.233
41	+1.214	0.133
42	+1.333	0.182
43	+1.409	0.301
44	+1.444	0.219
45	+1.577	0.212
Average	+1.038	0.485

Initial near Binocular add for Nepalese population is $+1.0383 \pm 0.485$ D (95% confidence interval [CI]; 1.101-0.975 D).

Discussion

Several possible factors could explain the wide agreement intervals observed here for the tests examined. The different methods used to determine tentative addition based on objective or subjective tests show low reliability. Indeed, this characteristic is true of many optometric tests. In particular, one would expect an especially low reliability while calculating addition power via the AA, due to the low AA range of the presbyopes. In addition, the absence of accommodative convergence when performing monocular tests to measure AA could underestimate the accommodative effectiveness of the visual system in binocular conditions while comparing with another binocular method to obtain a tentative addition. The dynamic retinoscopy method is partly subjective, in that it depends on both the examiner and the co-operation of the patient, who needs to make a conscious effort to keep the test image clear.

Several other factors, which relate to the conditions of each test and the particular characteristics of each subject (visual needs, work habits, previous prescription etc.) could contribute to the low agreement detected. In particular, the additions established by the age-based method reveal that subjects of similar age may require different additions, 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 tentative and final additions are compared. Hanlon, Nawakayashi and Shigezawa compared four procedures for establishing addition in terms of the percentage of errors². These authors reported that tentative additions based on binocular cross cylinder, NRA/PRA and AA measured by the push-up

procedure tended to overestimate the final addition, while the age-expected addition was closer to the definitive addition². But our findings indicate that the tentative addition determined from age-expected addition was not close to the definitive addition and the AA method underestimated the final addition ($p = 0.0001$). Similarly, tentative addition based on the NRA/PRA method is higher than the final addition in our study ($p = 0.0001$).

There are several methodological differences between our study and the study of Hanlon, Nawakayashi and Shigezawa that could explain the discrepancies observed². We adopted clear to blur (Duane's method) for measuring the AA at distance. We consider that this variation to the generally accepted method is more appropriate for the presbyopic patient, as it avoids the need to add plus lenses to achieve a clear starting image. Moreover, in our study the tentative addition was calculated as one half of the total amplitude of accommodation, which is similar to the study of Hanlon, Nawakayashi and Shigezawa².

Whitefoot 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 preference⁵. These authors conclude that dynamic retinoscopy has limited value for indicating the appropriate near addition, as it significantly over-estimates this value, which is not similar to our results⁵. They also conclude that using the age expected addition as the tentative power is as effective as conducting a dynamic retinoscopy to obtain the estimate⁵. In the study done by Rosen field M, Portello JK, Blustein GH, Jang C. accommodative response was measured by dynamic retinoscopy (neutralization being obtained both with lenses and by varying the working distance), dynamic cross-cylinder (with and without fogging lenses), and a near red-green duochrome test⁶. Under binocular conditions, the mean AR for all the tests were clinically equivalent⁶.

In various researches, comparison with the findings from the objective auto refractor indicated that dynamic retinoscopy (where neutralization was obtained by varying the working distance) showed the closest agreement, whereas the two dynamic cross-cylinder procedures exhibited the greatest variability⁶. For the monocular condition, the mean lag of accommodation observed with the auto refractor was significantly less than that observed with dynamic retinoscopy, cross-cylinder and duochrome method⁶. They have concluded that the technique of dynamic retinoscopy where the working distance is varied to obtain a neutral reflex should be the method of choice for the clinical assessment of the AR, because this procedure does not require the introduction of supplementary lenses, which may themselves alter the AR⁶.

These authors did not compare the level of agreement of these tests with the final addition. They demonstrate that the typical differences between dynamic retinoscopy determined additions and the final additions are high, suggesting low agreement between the two values. Over the years, numerous methods have been used to determine the power of the reading addition, often yielding different results.

Our findings suggest that all the studied techniques display similar result and provide a tentative addition close to the final addition. The method that provided the result closest to the final addition power was the dynamic retinoscopy procedure. This test shows the narrowest agreement interval and the least bias. All tests are similar in term of accuracy for the tentative addition, so, other aspects, such as ease of

application and time taken, will affect the choice of method. Finally, the wide agreements detected here suggest that every tentative addition should be adjusted according to the particular needs of the patients.

Table 3: Agreement between Tentative and Final Addition

Methods	Bias (D)	P value (T test)	COA (D)
AAL vs. ADF	+0.19 (ADF > AAL)	0.0001	±0.934
Age vs. ADF	+0.51 (ADF > Age)	0.0001	±0.847
RA vs. ADF	-0.19 (ADF < RA)	0.0001	±1.125
RET vs. ADF	+0.04 (ADF > RET)	0.052	±0.80

ADF = Final addition

COA = Coefficient of agreement

AAL = One-half amplitude of accommodation

Age = Based on patient age

RA = Balance of negative and positive relative accommodation

RET = Dynamic retinoscopy

Table 3 provides data on the level of agreement between each of the tests used to determine tentative addition in presbyopes and the final addition. Notwithstanding, the coefficients of agreement are moderately high in clinical terms, as they always exceeded ± 0.50 D. The extreme case was the tentative addition obtained by NRA/PRA method, for which the COA was ± 1.125 D. The agreement intervals level ranged from ± 0.80 D to ± 1.125 D. Similarly, our findings indicate that the tentative addition determined from dynamic retinoscopy is the closest to the final addition ($P = 0.052$). Amplitude of accommodation method with clear to blur criteria underestimates the final addition ($P = 0.0001$). Likewise, tentative addition determined from age-expected addition table is the least close to the final addition ($P = 0.0001$). Tentative addition based on the NRA/PRA is higher than the final addition ($P = 0.0001$) and it overestimate the final addition.

In the study done by Beatriz Antona, Francisco Barra et al. on 69 healthy subjects with a mean age of 51 years, the mean tentative near addition was higher than the final addition for every procedure except for the fused cross-cylinder without initial myopisation and age expected addition. These biases were small in clinical terms (less than 0.25 D) with the exception of the amplitude of accommodation procedure (0.34 D). The interval between the 95% limits of agreement differed substantially and was higher than ± 0.50 D⁷. There are several methodological differences between our study and that of Beatriz Antona et al. that could explain discrepancies observed⁷. We used for measuring the AA with clear to blur criteria (Duanes criteria) but they used minus lenses⁷. Likewise, amplitude of accommodation of Nepalese population is lower than age matched individual of that study. These could explain the discrepancies observed between the tentative additions obtained from AA method between the two studies. More ever, in our study the tentative addition with this method was calculated as one-half of the total AA, where as Beatriz et al. considered two-third of AA. The discrepancies obtained between tentative addition values obtained from dynamic retinoscopy between two studies could be due to variation in subjective response of the patients and differences in methodology of the technique Tentative addition based on the NRA/PRA addition is higher than the final addition ($P = 0.0001$) as similar to the study done by Beatriz.

Differences in the bias between tentative additions obtained from this method with final addition in three different studies could be due to variation in the subjective responses of the patients and differences in methodology and the techniques.

Our results indicate that the mean difference between tentative and final addition were generally low (less than 0.19 D), with the exception of the tentative values rendered by the age expected addition (bias = 0.51 D). This is probably due to the fact that we use age expected addition table proposed by pointer as the reference. It is because this table is recent than other consulted tables and no such tables have been proposed for Nepalese population till date. Due to short stature and arm length of Nepalese population, they have earlier onset of presbyopia and need add of slightly greater magnitude. This is the reason for discrepancies we obtained between our study and study of Anzona et al. in the age expected method of tentative near add determination. The addition power from pointer's table is significantly different from the final subjective acceptance in Nepalese population which may be responsible for large bias obtained between the tentative addition obtained from age expected addition and final addition in our study. Despite these differences being significant in many cases, they are clinically of little consequence, indicating that any of the methods used could provide an appropriate result close to the final addition.

Addition needed by Nepalese population is higher than age matched individual of the other countries. This may be due to the short stature and the arm length of the Nepalese population.

Table 4: Comparison of Age Expected Addition⁴

Age of Patient	Mean Add Current Study (D)	Pointer (D)
35	0.413±0.41	0.00
36	0.642±0.36	0.00
37	0.645±0.43	0.00
38	0.726±0.39	0.00
39	0.736±0.44	0.00
40	1.068±0.23	0.75
41	1.214±0.13	0.75
42	1.333±0.18	0.75
43	1.409±0.30	1.00
44	1.444±0.21	1.00
45	1.577±0.21	1.00
Total	1.038±0.48	0.477

Addition power in two places is significantly differences (p -value = 0.0001). This differences is also seen in our clinical experiences.

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