Reliability of Snellen's Hand-Held Near Acuity Chart on Presbyopic and Non-Presbyopic Subjects

Megbelayin Olu Emmanuel* and Yi-Hao Chen

Department of Ophthalmology, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung, Taiwan

*Corresponding Author: Emmanuel Olu Megbelayin, Department of Ophthalmology, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung, Taiwan.

Abstract

Purpose: The aim of the study was to determine the reliability of Snellen's Hand-held near acuity chart when compared with the conventional distance Snellen's Chart.

Methods: Convenience sampling technique was used to recruit 60 presbyopic and non-presbyopic subjects.

Results: Age range was 18 to 64 years with a mean age of 37.1 +/- 13.9. The male constituted a larger proportion of 61.7% (37 subjects). More than half, 35 (58.3%) of the subjects were not wearing glasses at the time of the study. There was no visual acuity category that had a difference above 20% between the two charts in the same eye. Visual acuity scores for the right eyes in both eyes had a p-value = 0.05 (99% CI = 0.000 - 0.122) and p-value was = < 0.0001 (99% CI = < 0.0001 - 0.074) on the left eyes.

Conclusion: Where standard distance Snellen's acuity is not available or cannot be used, hand-held Snellen's acuity chart is a useful option.

Keywords: Near Chart; Reliability; Snellen's Chart; Visual Acuity; E-Chart

Introduction

Visual acuity (VA) is the degree to which an observer's visual system can resolve spatial detail [1]. It indicates the angular size of the smallest detail that can be resolved. The visual targets to be recognized are called "optotypes," and typically they are letters, Landolt rings, or "tumbling E's" designed such that the width of the strokes and the gaps are one fifth of the height of the optotype character [2].

The first letter chart for the clinical measurement of visual acuity was designed by Hermann Snellen in 1865. In the original design, Snellen's acuity chart had a large letter at the top and below it were 6 rows of letters and numbers in progressively smaller sizes. The chart was viewed from a standard distance, and the size of the smallest letters that could be read provided the measure of VA. Since then, numerous modifications have been made to Snellen's original chart design, with changes being made to the selection and design of the letters or symbols, the range of sizes, the progression of sizes, the number of letters in the rows, and the spacing between letters and between rows [2-5].

The results of VA testing are usually expressed in Snellen's notation, which is the ratio of the test distance to the distance at which the critical detail of the smallest optotype resolved would subtend 1 minute of visual angle. Thus, a minimum angle of resolution (MAR)

of 1 minute of visual angle (or arc, sometimes abbreviated as "min arc") when tested at 20 feet (6 meters) is expressed as 20/20 (6/6), whereas an MAR of 10 minutes of arc if tested at 20 feet is expressed as 20/200 (6/60). Alternative means of expressing visual acuity are the decimal notation (the reciprocal of the MAR or the Snellen fraction), logMAR notation (the common logarithm of the MAR), the visual acuity rating, VAR, where VAR = 100 − 50 (logMAR), and the Snell-Sterling visual efficiency (VE = $0.2^{(MAR-1)/9}$) [2-4].

The standard for normal acuity has traditionally been considered to be 20/20 (6/6), although there are individuals who have better VA. Letter charts are used almost universally for VA testing of literate adults and school-age children in clinical and research settings. Alternative charts and other test procedures are sometimes necessary for testing infants and preschool children and other individuals who are unable to identify or respond appropriately to the letters or symbols on the chart.

The standard Snellen's chart design has evolved to meet exigencies at various times. One of such exigencies is determining vision in individuals who cannot assume sitting or standing position to read the conventional charts. These situations occur in bedridden individuals who due to medical conditions are permanently or temporarily confined to lying down. The ophthalmologist is sometimes invited to assess ocular status of in-patients by internists in environments where the standard 6m cannot be obtained or the standard chart is unavailable. The Hand-held Snellen's chart can become handy requiring only a reading distance of 40cm and can be read even in supine position. The current study sought to determine the reliability of Hand-head Snellen's chart when compared to the standard chart in the same environment. The outcome of this study will provide resourceful information to the clinicians and those involved in vision research.

Materials and Methods

Hand-held tumbling E chart was used at 40 cm because the Committee [6] on Vision recommended 40 cm for near visual acuity testing. To ensure a constant near distance at all times, a 40 cm cord attached to the near chart was stretched from the near chart to the lateral canthus whenever each subject read the chart. The Hand-held E chart had the topmost E a single optotype and labeled "60" such that individual who read only that line was dimmed to have scored 20/200 (6/60) for near acuity reading. The seventh line of the hand-held acuity chart was labeled "6" such that individuals who read all the optotypes in the chart including the last rows of E's were dimmed to have scored 20/20 (6/6) for near acuity reading. After, subjects read standard Snellen's tumbling E chart at 6m. The distance E chart had the same configuration as the Hand-held chart and scoring followed the already described pattern above. Both charts were read without corrective lenses. One eye was occluded by an occluder when the other eye was reading the chart.

The choice of E charts was to ensure the optotypes were not easily memorized. Subjects were instructed to use a wave of hand in the direction of the opened end of optotype "E" to indicate the appropriate direction. The subjects were allowed to freely read the chart until a whole line of optotypes was missed. What was then calculated was based on the last optotype the subject got correctly. This was to ensure that the correct VA readings were recorded.

Convenience sampling technique was adopted and subjects were recruited until the calculated sample size was attained. The inclusion criteria were adequate subjects' cooperation to read the chart correctly, granting of informed consent and the participants should not be too sick as to compromise the VA scores. Subjects who did not grant consent, those who did not understand the instructions for the study and subjects too sick to give reliable responses were excluded. Study design conformed to Helsinki declaration. The study was conducted in an outpatient eye clinic with both charts illuminated with fluorescent bulbs adapted for them. There were no shadows or reflections to compromise the reading of the charts. Optotypes were in black prints on white background for optimum contrast. Subsequently, questionnaires were administered and subjects were assisted were necessary to fill the questionnaires.

For the purpose of statistical analysis, subjects who read Rayner's chart worse than N6 were considered presbyopic. Data collected were coded and entered into SPSS version 20.0 for analysis. An Alpha level of 0.05 was used to assess statistical significance using p value

at 99% confidence interval (CI). The Null hypothesis was that there were no differences in VA scores between the near acuity chart and the standard distance Snellen's chart.

Result

Sixty subjects aged 18 to 64 participated in the study with a mean age of 37.1 +/- 13.9. Gender distribution was such that male constituted 61.7% (37) and female 38.3% (23). A cross-tabulation of age and sex showed a p-value = 0.683 (99% CI = 0.529 - 0.838) which was not statistically significant. More than half, 35 (58.3%) of the subjects were not wearing glasses at the time of the study. Of those not wearing glasses, 5 (8.3%) had used refractive spectacles in the past. Based on the defined criterion, 32 (53.4%) were presbyopic. See table 1 and figure 1.

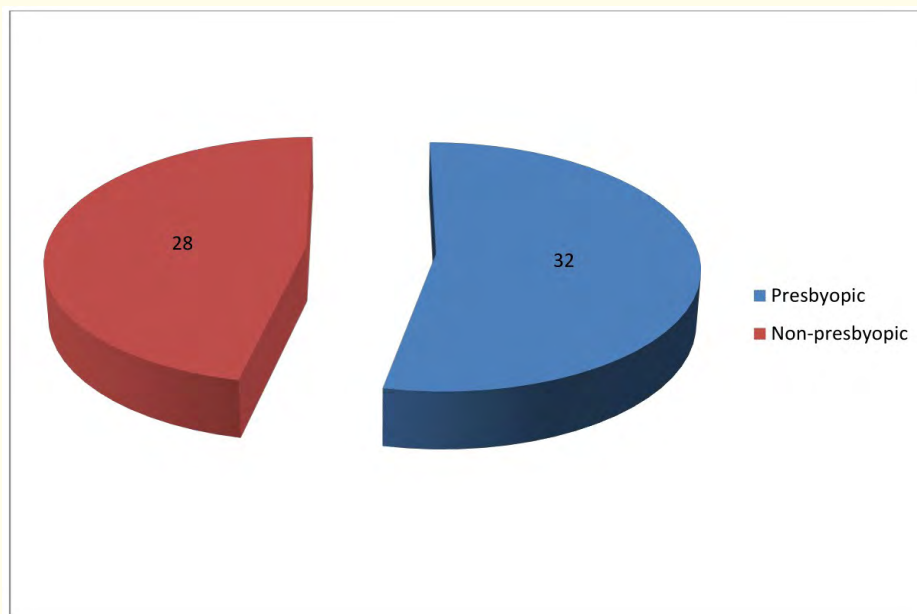| Near Acuity	Frequency	Percentages
N5	28	46.7
N6	4	6.7
N8	3	5.0
N10	8	13.3
N12	6	10.0
N18	3	5.0
N24	5	8.3
N14	3	5.0
TOTAL	60	100.0

Table 1: Near acuity scores.

Figure 1: Refractive status.

The unaided VAs in both charts were compared in each subject and tabulated in table 2. Comparisons were based on performances on the same optotype line of each chart. From table 2, there was no VA category that had a difference above 20% between the two charts. There were categories that had no difference or the difference was as low as 0.7%.

VA	Acuity Using Distance Chart				Acuity Using Near Chart			
	Right Eye		Left Eye		Right eye		Left eye	
	f	%	f	%	f	%	f	%
≥ 6/18	55	91.7	50	83.3	44	73.3	42	70
≤ 6/18 - 6/60	5	8.3	7	11.7	15	25	14	23.3
≤ 6/60-3/60	0	0	1	1.7	1	1.7	1	1.7
≤ 3/60-NPL*	0	0	1	1.7	0	0	2	3.3
ES**	0	0	1	1.7	0	0	1	1.7

Table 2: *Comparison of visual acuity scores in both Charts.*

NPL*: No Perception of Light, ES**: Empty socket

Table 3 shows that the performances on the same line of both charts corresponded in 29 (48.3%) on the right eyes and 31 (51.7%) on the left. If VAs were considered to correspond (within plus or minus two lines margin) in both charts, then the margin of non-correspondence of the charts was narrowed to less than 20% (table 3).

	Right Eyes		Left Eyes	
Outcomes	f	%	f	%
Corresponded (same scores) in both charts	29	48.3	31	51.7
A line better on near acuity	1	1.7	1	1.7
A line worse on near acuity	4	6.7	5	8.3
2 lines better on near acuity	1	1.7	1	1.7
2 lines worse on near acuity	13	21.7	12	20.0
More than 2 lines worse on near acuity	12	20.0	10	16.7

Table 3: *Visual Acuity Scores on the Right Eyes and Left Eyes on the same Optotype Line of both Charts.*

VAs were cross-tabulated in both eyes for both charts. VA scores for the right eyes in both eyes had a p-value = 0.05 (99% CI = 0.000 - 0.122). This was statistically significant. However, when adjustment was made with the diagnosis made in each patient (whether presbyopic or non-presbyopic), p-value was = 15.657. This was not statistically significant. The same computation was done on the left eye, p-value = < 0.0001 (99% CI = < 0.0001-0.074). This was statistically significant. However, when adjustment was made with the diagnosis (presbyopic or non-presbyopic), p-value = 0.592 (99% CI = 0.523 - 0.610). This was not statistically significant.

Discussion

Studies comparing VA using the same optotypes at near (40 cm) and distance (6m) are sparse. Only very limited studies have compared them and examined the extent of their similarity. Majority of available studies have focused on using either or both charts to access the visual status of the research population being the single most informative clinical measurement in detecting significant abnormalities affecting the visual system. Additionally, VA is often used to detect and monitor progress in visual disorders, and is usually the main factor in initiating, changing, or continuing treatment [4-8]. This then underscores the relevance of having sufficient research-based information about any tool used in assessing any part of visual function.

It can be assumed that if near vision test chart has the same or similar design features as the letter chart used for distance VA, if other test conditions (luminance, contrast, and others) are the same, and if the subject is wearing appropriate refractive error correction, then the distance and near VA scores should be equivalent to each other. The current study found that the unaided VA scored in the same eye for the two charts were comparable. This is to the extent of clinical applicability.

The current study noted that both charts gave similar readings up to 80% (Right eyes) and 83.3% (Left eyes) when VAs are considered to correspond within plus or minus two lines difference. Lovie-Kitchin and Brown [9] reported a difference of approximately one-half line (two letters) between distance and near visual acuity measured with Bailey-Lovie charts in 24 individuals between 25 and 77 years of age. The optotype difference between the current study and that of Lovie-Kitchin., *et al*. [10] could be on account of disparities in the chart used, the smaller sample size in the earlier study and different test environments. In a more recent study [9] among a larger sample size of 78 individuals between 21 and 68 years of age, similar to the current study of 60 individuals between 18 to 60 years, Lovie-Kitchin and Brown found a difference of one line between distance and near acuity. This closely conforms to the finding in the current study.

It was interesting to note that statistical significance existed between the VA scores when both charts were compared. But when adjusted for by the diagnoses, there was no statistical significance. This underscored the role of presbyopia among the slightly higher presbyopic subjects. Variations in accommodation, pupil size, and/or depth of focus seamed to play a huge role in near chart-distance chart mismatch. But this does not reduce the clinical use of Hand-held acuity chart to determine distance vision especially when constrained by non-availability of either optimum environment or standard distant Snellen's acuity chart.

From table 2 in this study, the performances in the distance acuity chart were better than the chart read at near. This could be attributed largely to non-correction of near vision in older, presbyopic subjects who were tested without corrective lenses.

From the findings in this study, it can be affirmed that where near corrections are in place, distance VAs, whether conducted at a standard distance of 6m or reading distance of 40 cm, are closely similar. On the other hand, where near corrections are not used during reading, the scores obtained could be taken as either similar or patient actually has a better vision up to two lines if distance chart had been used. This should be noted because VA scores, other than clinical implications, are useful for legal purposes such as eligibility standards for certain occupational tasks and licenses, for benefits, and for financial compensation in insurance claims.

For consistency and to enhance comparison of results, it is recommended that there should be standardization of chart designs. It is also likely that use of presbyopic correction will closely approximate the VA scores obtained from Hand-held Snellen's chart with the conventional distance Snellen's chart read at 20 feet (6m). This should be borne in mind when making clinical judgments or during visual status certification in bed-ridden persons.

Conflict of Interest

None.

Bibliography

1. Bennet AG and Rabbets RB. "Clinical Visual Optics". 3rd ed. Boston: *Butterworth-Heinemann* (1998): 19-26.

2. Lennie P and Van Hemel SB. "Visual Impairments: Determining Eligibility for Social Security Benefits. National Research Council (US) Committee on Disability Determination for Individuals with Visual Impairments". *National Academies Press* (2002).

3. Scheiman M and Rouse M. "Optometric Management of Learning-Related Vision Problems". 2nd ed. Boston: *Elsevier Health Sciences* (2005): 336-337.

4. William B. "Borish's Clinical Refraction". 2nd ed. Boston: *Butterworth-Heinemann* (2006): 217-246.

5. Eperjesi F and Rundstrom MM. "Practical Binocular Vision Assessment: A Practical Guide". *Boston: Elsevier Health Sciences* (2004): 5-15.

6. Committee on Vision. "Recommended standard procedures for the clinical measurement and specification of visual acuity. Report of working group 39. Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences, Washington D.C". *Advances in Ophthalmolology* 41 (1980): 103-148.

7. Colenbrander A. "Aspects of vision loss -- visual functions and functional vision". *Visual Impairment Research* 5.3 (2003): 115-136.

8. Pointer JS. "Habitual vs optimal distance visual acuity. Ophthalmic and physiological optics". *The Journal of the British College of Ophthalmic Opticians* 28.5 (2008): 457-466.

9. Lovie-Kitchin JE and Brown B. "Repeatability and intercorrelations of standard vision tests as a function of age". *Optometry and Visual Science* 77.8 (2000): 412-420.

10. Lovie-Kitchin JE. "Validity and reliability of visual acuity measurements". *Ophthalmic Physiolology and Optometry* 8.4 (1988): 363-370.

Volume 6 Issue 2 April 2017