Comparison Between Visual Acuity Measurement On Logmar Chart and Velorum Visual Acuity System In Emmetropic Individuals

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ABSTRACT

PURPOSE: *The purpose of this study is to evaluate the agreement of visual acuity measurements between Velorum Visual Acuity System (VVAS) and gold standard LogMar chart.*

MATERIALS AND METHODS: *It was a quantitative comparative cross-sectional study. Visual acuity on Velorum Visual Acuity System was noted after calibration of the system for the monitor at the distance of four meters from the patient. LogMar chart was also placed at 4 meters of distance.The sample size was 128 eyes.*

RESULTS: *The Cohen's Kappa test showed significant agreement between LogMar and VVAS chart ($\kappa = 0.453$, $p < 0.001$ up to one decimal and $\kappa = 0.159$, $p < 0.001$ up to two decimal places).*

CONCLUSION: *There is no significant difference between the visual acuity score withVelorum Visual Acuity System and with LogMar chart. VVAS can be used in place of the LogMar chart.*

KEYWORDS: *Visual acuity, LogMar, Measurements*

INTRODUCTION

Visual acuity is one of the most important visual functions, whichcan be assessed easily by the use of simple equipment. Visual acuity (VA) can be defined as the "spatial resolving ability" of an eye or,Visual acuity in ophthalmologic or optometric setting, is an ability to differentiate between two stimuli which are separated in space at high contrast as compared to the background.[1] VA can be assessed by measuring the angle that is subtended by the smallest optotype recognized by the eye. In theory, it shows the function of the macula, but in reality, it represents the status of the visual system, which includes the entire visual pathways.[2] Emmetropia is said to be an optical state in which parallel light rays after passing through the optical media converge on the neurosensory retina when the eye is not accommodating.[3] Optically, the second principal focus of a resting; the non-accommodating eye does not fall on the retina.[4]

The measurement of visual acuity is the representation of the most conventional and helpful test for assessing visual functions thus, it is an important part of the eye examination.[5] Wong and Kaye proposed that different charts may be helpfulfor catering particular needs, and each of these charts should balance specificity, sensitivity and the desiredtime needed for examination.[6] Numerous charts are being used to test visual acuity, but Snellen and ETDRS charts are the most common ones. The Snellen chart is currently used as a standard for measuring VA in clinical settings because of its easy accessibility as well as it is quick and simple to perform.[2] It was first introduced by Dr. Hermann Snellen who was a Dutch ophthalmologist in 1862. Although easy to use Snellen chart has numerous disadvantages.[7] Each line having a varying number of optotypes, with variable size of optotypes, and using line assignment method to test the visual acuity being a few. Also, the legibility of letters on Snellen is not always the same. Some letters like (O, G, E, D, C) have more legibility than the others (e.g. A, L, J).[8,9] Moreover, the distance between adjacent letters and descending rows is not uniform. Studies showed that adjacent contours being too closely spaced give rise to an effect known as crowding phenomenon, which reduces acuity.[10]

In order to overcome the shortcomings of the Snellen chart,

many suggestions were put forward for improving chart design and measuring visual acuity with more accuracy. In this regard, Dr. Ian Bailey and Jan Lovie proposed the most popular redesign in 1976.[7] It consisted of the following characteristics:

- The letters on the chart had a height that was equivalent to 5 strokes wide and was with no serif. This assured that difficulty in a given line was only determined by the size of the letter. [2]
- Each row comprised of 5 "Sloan" letters, and the chart consisted of 14 rows having 70 letters. Dr. Sloan proposed Sloan letters a set of 10 uppercase letters, non-serifed, which were formed within a square outline, having a stroke width equal to one-fifth to that of the height of the letter (D,V, H, C, K, S, O, R, N, Z), and having same legibility.[11]
- The spacing between optotypes and rows was according to proportion to that of size of the letter. There was one letter-width space between letters and spacing between the rows was equal to that of the height of those letters placed in the smaller row. The crowding phenomenon was prevented by following which was seen in the Snellen chart. [2]
- The ETDRS chart showed significantly better TRV than the Snellen chart varying from ± 3.5-10 letters, depending on whether the patient possessed normal visual acuity or had any ocular pathology.[12-16]

In this research we used a newly developed chart Velorum Visual Acuity System; version 3.6 for assessing different visual functions, but here we were only concerned with visual acuity evaluation.

The logarithmic increase in print size on these charts can be conducive in predicting the numberof changes in visual performance as a result of changes in optical dimensions needed to accomplish desired levels of visual performance[17]

METHODOLOGY:

Ethical clearance to conduct the study was taken from the College Of Ophthalmology And Allied Vision Sciences, King Edward Medical University,Lahore. A quantitative comparative cross-sectional study methodology was employed. Visual acuity of 128 eyes was taken by using the LogMar chart at a distance of four meters and on Velorum Visual Acuity System after calibration of the system for the monitor and for the distance of four meters from the patient. Successful interactive discussion session with participants about the procedure of taking visual acuity was ensured. A consent form in the English language including information related to purpose, significance and intended procedure of research study was completed and signed by each participant.The entire procedure was monitored in the outdoor patient department carefully and vigilantly. Examination with both the LogMAR and Velorum visual acuity system was performed by one examiner in the same room under the same light condition. The order in which the charts were shown to each patient was randomized. An average of three measurements was taken as the final score and test was terminated with if three wrong optotypes were read for the same line. Data werecollected and entered using SPSS Version 20. A quantitative cross-sectional study was done using descriptive statistics. Cohen's Kappa test was employed to find the agreement between these two charts up to two decimal places. The test showed significant agreement (moderate agreement $\kappa = 0.453$, $p < 0.001$ up to one decimal) and (slight agreement $\kappa = 0.159$, $p < 0.001$ up to two decimal places)

RESULTS:

Table 1:

Agreement Chart LogMar v/s VVAS up to one Decimal

Up to one decimal level		VVAS					Total
		-0.3	-0.2	-0.1	0	0.1	
LogMar	-0.2	2	40	2	0	0	44
	-0.1	0	26	37	2	0	65
	0	0	0	10	7	2	19
	0.1	0	0	0	0	0	0
Total		2	66	49	9	2	128

Agreement between LogMar and VVAS score upto one decimal level is shown. 44 eyes scored -0.20 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 2 of them gave -0.30, 40 gave -0.20, 2 gave -0.10 on VVAS chart. 65 eyes scored -0.10 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 26 of them gave -0.20, 37 gave -0.10, 2 gave 0.00 on VVAS chart. 19 eyes scored 0.00 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 10 of them gave -0.10, 7 gave 0.00 on VVAS chart. 19 eyes scored 0.00 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 10 of them gave -0.10, 7 gave 0.00 on the VVAS chart.

Table 2:

Cohen's Kappa Test Findings

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	.453	.063	7.215	.000
N of Valid Cases		129			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

The Cohen's Kappa test showed significant agreement between LogMar and VVAS chart ($\kappa = 0.453$, $p < 0.001$ up to one decimal)

TABLE 3:

Agreement Chart LogMar v/s VVAS up to 2 decimals															
Up to two decimal -.25		VVAS													Total
		-.20	-.18	-.16	-.15	-.10	-.08	-.06	-.05	-.04	-.03	.00	.05	.10	
LogMar	-.20	2	12	10	1	3	0	0	0	0	0	0	0	0	28
	-.18	0	7	1	2	0	1	0	0	0	0	0	0	0	11
	-.16	0	0	3	0	0	1	0	0	0	0	0	0	0	4
	-.15	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	-.10	0	4	1	2	12	17	3	2	9	0	0	1	0	0	51
	-.08	0	0	0	0	4	1	0	1	0	0	0	0	0	0	6
	-.06	0	0	1	0	2	2	1	0	1	1	0	0	0	0	8
	-.02	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	.00	0	0	0	0	0	2	0	0	8	2	1	3	2	0	18
	.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		**2**	**23**	**16**	**5**	**22**	**24**	**4**	**3**	**18**	**3**	**1**	**5**	**2**	**0**	**128**

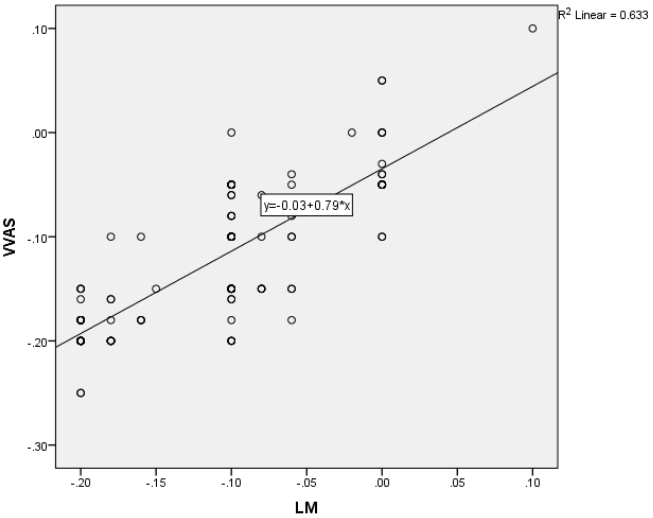
The agreement between LogMar and VVAS score upto two decimal levels is shown. 28 eyes scored -0.20 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar, 2 of them gave -0.25, 12 gave -0.20, 10 gave -0.18, 1 gave -0.16, 3 gave -0.15 on VVAS chart. 11 eyes scored -0.18 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 7 of them gave -0.20, 1 gave -0.18, 2 gave -0.16, 1 gave -0.10 on VVAS chart. 4 eyes scored - 0.16 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 3 of them gave -0.18, 1 gave -0.10 on the VVAS chart. 1 eye scored -0.15 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 1 of them gave -0.15 on the VVAS chart.51 eyes scored -0.10 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 4 of them gave -0.20, 1 gave -0.18, 2 gave -0.16, 12 gave -0.15, 17 gave -0.10, 3 gave -0.08, 2 gave -0.06, 9 gave -0.05 and 1 gave 0.00 visual acuity on VVAS chart. 6 eyes scored -0.08 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 4 of them gave -0.15, 1 gave -0.10, and 1 gave -0.06, visual acuity on VVAS chart. 8 eyes scored -0.06 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 1 of them gave -0.18, 2 gave -0.15,2 gave -0.10, 1 gave -0.08, 1 gave -0.05, 1 gave -0.04 visual acuity on VVAS chart. 1 eye scored -0.02 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 1 of them gave 0.00 visual acuity on the VVAS chart. 18 eyes scored 0.00 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 2 of them gave -0.10,8 gave -0.05, 2 gave -0.04, 1 gave -0.03, 3 gave 0.00, 2 gave 0.05 visual acuity on VVAS chart.

TABLE 4:
Cohen's Kappa Test Findings Up to 2 decimals

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	.159	.038	5.216	.000
N of Valid Cases		129			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

The Cohen's Kappa test showed significant agreement between LogMar and VVAS chart ($\kappa = 0.159$, $p < 0.001$ up to two decimal places).



The figure shows a Scatter plot of a visual acuity score of 128 eyes obtained from LogMar and VVAS charts. The solid line at 45° is the locus for perfect agreement between the visual acuity scores obtained from both charts.

DISCUSSION

According to our knowledge, this study shows the first direct attempt to compare and evaluate any agreement between LogMar; a gold standard chart considered in the field of ophthalmology and optometry with that of Velorum Visual Acuity System which is new computer software intended to measure visual acuity with as much accuracy. This study focused on the comparison between visual acuity measurements on LogMar and VVAS and agreement between both these charts. A total of 128 eyes were included in this study and Cohen's Kappa test was used to statistically analyze the visual acuity score of both these charts.Studies that involve finding the agreement between two or more observations should use a statistic thatmakes use of the fact that researchers will sometimes agree or disagree on some observations simply by chance. The kappa statistic also known as the kappa coefficient is the most commonly used statistic test for this purpose. A kappa of 1 shows perfect agreement, whereas a kappa of 0 shows agreement equal to chance. Kappa is used to quantitatively measure the extent of agreement between the observations. [18]

In this study, the Cohen's Kappa test showed significant agreement between LogMar and VVAS chart ($\kappa = 0.453$, $p < 0.001$ up to one decimal and $\kappa = 0.159$, $p < 0.001$ up to two decimal places). A study graded Kappa value of 0.41-0.60 as moderate agreement and 0.01-0.20 as slight agreement.[19]

The agreement between LogMar and VVAS score upto one decimal level is shown in table 1. A total of 44 eyes scored -0.20 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar, 2 of them gave -0.30, 40 gave -0.20, 2 gave -0.10 on VVAS chart. Sixty-five eyes scored -0.10 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 26 of them gave -0.20, 37 gave -0.10, 2 gave 0.00 on VVAS chart. Nineteen eyes scored 0.00 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 10 of them gave -0.10, 7 gave 0.00 on the VVAS chart.

The Cohen's Kappa test showed significant agreement between LogMar and VVAS chart ($\kappa = 0.159$, $p < 0.001$ up to two decimal places). The agreement between LogMar and VVAS score upto two decimal levels is shown in the table. Twenty-eight eyes scored -0.20 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar, 2 of them gave -0.25, 12 gave -0.20, 10 gave -0.18, 1 gave -0.16, 3 gave -0.15 on VVAS chart. Eleven eyes scored -0.18 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 7 of them gave -0.20, 1 gave -0.18, 2 gave -0.16, 1 gave -0.10 on VVAS chart. Four eyes scored - 0.16 visual acuity score on the LogMar chart. The eyes having this visual acuity onLogMar 3 of them gave -0.18, 1 gave -0.10 on VVAS chart. 1 commoneye scored -0.15 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 1 of them gave -0.15 on the VVAS chart. Fifty-one eyes scored -0.10 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 4 of them gave -0.20, 1 gave -0.18, 2 gave -0.16, 12 gave -0.15, 17 gave -0.10, 3 gave -0.08, 2 gave -0.06, 9 gave -0.05 and 1 gave 0.00 visual acuity on VVAS chart. Six eyes scored -0.08 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 4 of them gave -0.15, 1 gave -0.10, and 1 gave -0.06, visual acuity on VVAS chart. Eight eyes scored -0.06 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 1 of them gave -0.18, 2 gave -0.15,2 gave -0.10, 1 gave -0.08, 1 gave -0.05, 1 gave -0.04 visual acuity on VVAS chart. 1 eye scored -0.02 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 1 of them gave 0.00 visual acuity on the VVAS chart. Eighteen eyes scored 0.00 visual acuity score on the LogMar chart. The eyes having this visual acuity on LogMar 2 of them gave -0.10,8 gave -0.05, 2 gave -0.04, 1 gave -0.03, 3 gave 0.00, 2 gave 0.05 visual acuity on VVAS chart.

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