Original Article

Saving space: Comparing mini - logMAR with standard logMAR visual acuity

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Purpose: Assessing visual acuity (VA) is the cornerstone of an ophthalmic workup and needs VA charts in a four or six meters space. The objective of this study was to compare the performance of distant VA (DVA) on one meter mini-logMAR (MLM) with a standard six meter logMAR (SLM) chart. **Methods:** We developed a MLM chart to be used at 1 m with +1.0 D spectacles, by reducing the SLM chart designed for 6 meters, to 1/6th its size, using AutoCAD version 2014. On an initial cohort, we obtained DVA on the two charts by optometrist trainees, masked to the outcomes on the different tests. We performed regression and checked agreement between the two measurements. Subsequently, on a new cohort, we validated the performance of the MLM. **Results:** Of the 56 initial subjects, mean DVA with SLM was 0.44 ± 0.13 and with MLM was 0.45 ± 0.13; mean difference of -0.01 ± 0.02, 95%CI: 0.007 to 0.018; $P < 0.0001$ on paired *t*-test. There was a significant correlation: r = 0.99; r^2 = 0.98, $P < 0.0001$. On an average, DVA with MLM was less than a letter worse than with SLM. The regression formula obtained: SLM DVA = -0.1312 + 1.0014 x (MLM DVA). The validation study revealed no significant difference ($P = 0.29$) between the predicted standard DVA calculated by the regression formula and the actual standard. **Conclusion:** We suggest that we can deduce distance logMAR VA from a mini-logMAR chart as devised and used by us. This will take less space, be portable and allow congenial interaction with patients.

Key words: Agreement, distant visual acuity, mini-logMAR, regression, standard logMAR

Visual acuity (VA) assessment is basic to any eye examination. It is commonly performed at 20 feet (6 meter) using Snellen, logMAR, or decimal notation. The VA assessed on logMAR is considered the current standard of measurement.[1-3] Commonly used standardized vision charts such as Snellen and the ETDRS logMAR charts, are designed for six, four or three meters, and consume precious space.[4-6] Several modifications and strategies have been developed to make VA assessment not only reliable, but also simpler, faster and feasible within small spaces.[7-9] Leas symbol, Pocket vision screener chart and smartphone-based Peek acuity, Eye Hand Book and Eye Chart Pro are some of them.[10-13] Although, smartphone-based visual acuity applications are easily available and considered handy, they not only incur an additional cost but also reflection from the screen poses challenge for recording visual acuity. Also, these applications were designed to assess near VA, while we have checked distant visual acuity (DVA) at near. It is our contention that checking DVA at near would simplify the test, be more child friendly, and save space. We have not come across any article on assessing the DVA at a one meter distance while using the +1.0 D lens. Therefore, we designed a special chart for carrying out distant visual acuity testing at one meter; the mini-logMAR chart. This study intended to analyze the correlation, regression and agreement between mini-logMAR chart (MLM) with that of standardized six meter logMAR chart (SLM) to compare DVA.

Methods

After obtaining informed consent from the patients and/or parents, we conducted a parallel design study, where in, a cohort of subjects were assessed for DVA, using both MLM and SLM charts. The study was conducted over a 3-month period from September 2017- November 2017. We included patients above five years of age attending the eye outpatient clinic of the medical college, where DVA is universally assessed for all attendees. Non-cooperative patients, patients not consenting, or those with visual acuity worse than 20/200 (<1.0 logMAR) were excluded. We also excluded cases with obvious media opacities, had nystagmus or strabismus, and those who had undergone any ocular surgery.

We developed a tumbling-E notation mini-logMAR chart to be used at one meter based on the following rationale:

Since it was to be used at 1/6th the distance, we accordingly uniformly miniaturized the standard ETDRS chart to 1/6th of the original, using AutoCAD version 2014. The original chart consisted of 12 rows with the top most row measuring 1.0 logMAR and the lowest row measuring -0.1 logMAR [Fig. 1]. For the MLM, we used a pair of +1.0 Diopter (D) spectacles, anchored to the MLM chart with a non-stretchable one meter cord to compensate for the dioptric distance.

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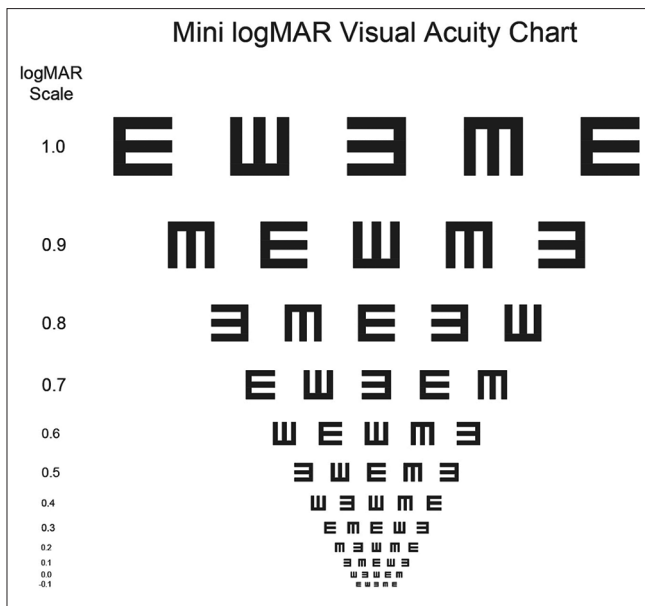
Figure 1: MLM chart developed for DVA assessment at one meter

Figure 2: Box plot distribution of average DVA of the two eyes obtained through SLM Vs MLM

The rationale behind the use of 1.0 D spectacle was to make diverging rays coming from one meter MLM chart, parallel to the optical system of eye simulating an optical infinity. Unaided DVA of each eye of the patient was recorded first using SLM at six meter, and then with MLM at one meter while wearing the +1.0 D spectacles. Both recordings were carried out by different persons, each of whom was unaware of the result on the other testing method.

Sample size calculation

Using the SD of 0.15 logMAR from literature[14] and a meaningful difference of 3 logMAR letters, viz. 0.06 logMAR, for a paired t-test, with α of 0.05 and a power of 80%, we needed around 58 subjects.[15]

Validating study

On another cohort of 64 subjects, the DVA of the subjects was first recorded on MLM, then the predicted standard DVA was calculated by the regression formula obtained with the original cohort described above. This calculated DVA was then compared with the DVA recorded on SLM.

Statistical analysis

The average of DVA values of the two eyes was calculated[16-18] and correlation, regression and agreement analysis were done using JASP 0.9.0.1[19] and Medcalc statistical tools.[20,21] The paired t-test was used for difference of means. Significance was set at $P < 0.05$. 95% CI are quoted where possible.

Results

A total of 56 patients, 27 males and 29 females, were included in our original cohort. The mean age in years was 30.52 ± 15.79, ranging from 8-65 (median: 28 years).

Mean DVA in logMAR measured with SLM was 0.44 ± 0.13, ranging from 0.25-0.76 (median: 0.38) and with the MLM was 0.45 ± 0.13 ranging from 0.24-0.78 (median: 0.4). The mean difference between the two measures was -0.01 ± 0.02 logMAR with 95%CI: -0.007 to -0.018; $P < 0.0001$ [Fig. 2]. Pearson's
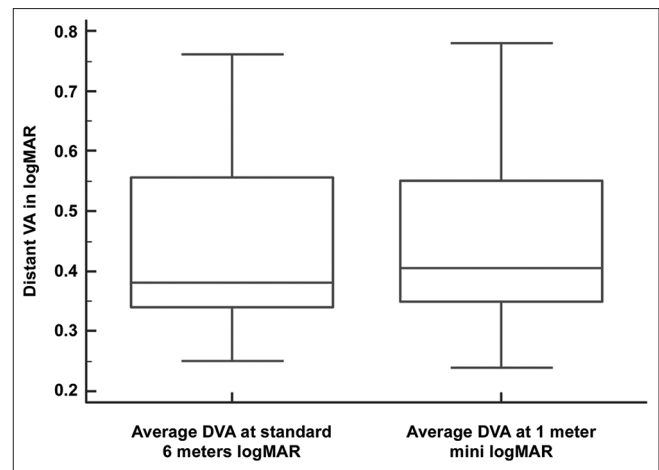
test found a significant and substantial correlation between the 2 measures (Pearson's coefficient r = 0.99; 95% CI: 0.98 to 0.99 ($P < 0.0001$).

Regression analysis shows that about 98% of the variation on DVA measured with SLM was explained by that with MLM (r^2 of 0.98), [Fig. 3]. The regression equation so found was:

logMAR DVA on SLM at 6 m = -0.01312 + 1.0014 (DVA on MLM at 1 m).

Reflecting the findings on paired *t*-test, the Bland-Altman agreement plot, revealed that on average the DVA on MLM was 0.013 logMAR worse, compared to the SLM, [Fig. 4].

For validation, we collected DVA data on a new cohort of 64 subjects; 30 males and 34 females, with mean age of 31.15 ± 14.72 years, ranging from 6-56 years (median: 27.0 years). Using the regression formula, the predicted SLM DVA was 0.41 ± 0.29 logMAR, ranging from -0.01 to +0.98 (median; 0.29) logMAR: while that of observed DVA at six meter logMAR chart was recorded as 0.39 ± 0.33 logMAR, ranging 0.0-1.0 (median: 0.3) logMAR: resulting in a non-significant mean difference of 0.01 logMAR with 95% CI -0.01 to 0.04 ($P = 0.29$) on paired *t*-test, [Fig. 5].

Discussion

Clinicians around the world have attempted to find out different ways for assessment of VA that is feasible at smaller spaces, quick and reliable.[22-29] Several modifications have been made to resolve the shortcomings of the standard six meter VA charts. Modified four and three meter VA charts have shown good reliability in several studies and are now regarded as standard in various parts of the world.[22,23]

In 2001, Rosser *et al.*, in 51 subjects of 49-89 years, compared the test-retest variability, agreement and time taken for logMAR VA assessment by newly designed reduced logMAR (RLM) charts with standard ETDRS charts and Snellen charts at six meter. The RLM chart with 3 letters in a row (1 letter = 0.033 logMAR) produced VA data which were completely in agreement with ETDRS having a mean difference of 0.0 ± 0.01; 95% confidence interval of -0.03 to + 0.03. Also, the VA assessment with RLM was half the time quicker than those on
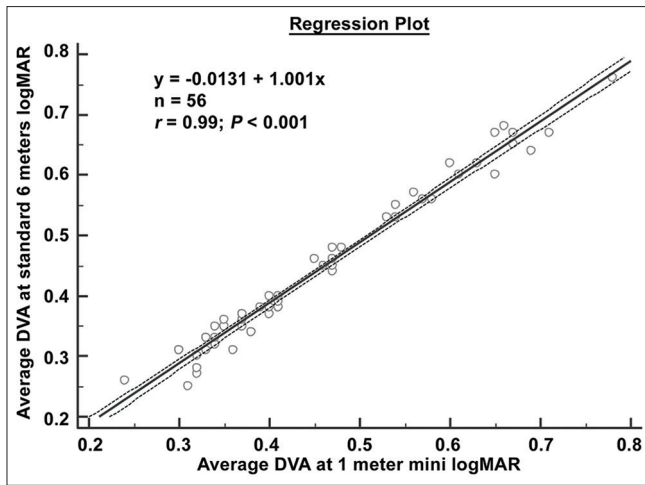
Figure 3: Linear regression plot of average DVA of the two eyes obtained through SLM Vs MLM: dotted line represents 95% CI
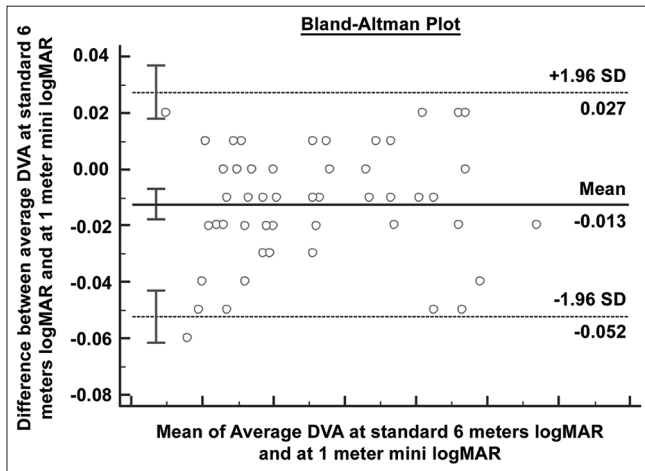

Figure 4: Bland-Altman plot for average DVA of the two eyes obtained through SLM Vs MLM: bars representing 95% CI
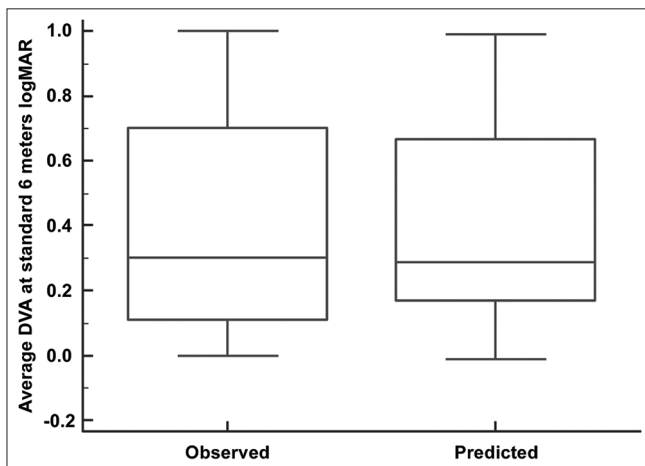

Figure 5: Box plot distribution of average predicted standard DVA and actual observed standard DVA

ETDRS. This study concluded that the RLM being comparable in variability with ETDRS can save time in routine clinical practice.[5] Unlike ours, this study tested VA at six meters. While our study design, intended to save spaces, assessed DVA at a shorter distance of one meter.

Pocket Vision screener developed in 2014 under aegis of Sankara Nethralaya, Chennai, was studied to screen visual acuity deficits among wide range of population. They found this screening tool as 81% sensitive and 94% specific (Positive Predictive Value of 81% and Negative Predictive value of 97%). It was considered quick, relatively easy and handy for the use in mass vision screening.[10]

Recently smartphone-based applications are gaining popularity. In 2015, Bastawrous *et al.*[26] and Brady *et al.*[27] compared a smartphone-based Peek Acuity app with standard ETDRS and Snellen charts at 3 and 4 meters. They found that VA with Peek acuity app was agreeing well with standard procedures with an insignificant difference of 0.08 with a good repeatability. Later, reliability of various other smartphone apps like Eye Hand book, Eye Chart pro were assessed, but none of them looked at distant VA.[11-13]

Our study compared the DVA on standard logMAR at six meters with the newly developed mini-logMAR which showed a strong and significant positive correlation, and that is as it should be, since they essentially measure the same entity. Equally interestingly they revealed an extremely good agreement. Most prior studies have compared the reduced logMAR with the SLM but have not performed the agreement analysis.[20-22] The regression equation suggests that DVA at one meter mini-logMAR chart using +1.0 D was worse than that on six meter standard logMAR chart by less than a letter. Furthermore, the validation study proves that the regression equation derived works well.

Limitations: Our study cohort largely comprises middle aged population. Therefore, the results cannot be extrapolated to pediatric population. Also, there remains the possible effect of associated refractive error and the blur at near induced by 1 D lens, which we have not factored in. We feel future research should include refractive data to explore whether the myope and the hyperope differ, if at all. Also, we should include children with strabismus and special groups like school drop outs to increase the generalizability of this work.

Conclusion

Our study serves to demonstrate that the distant VA assessed by the MLM with +1.0 D spectacles agrees well with the SLM, and not only are less expensive than smartphones but also, has the advantage of saving space, allowing better interaction with patients and can certainly be a viable option as a screening modality in eye clinics as well as in the field.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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