TECHNICAL NOTE

A practical logMAR near reference table for low vision practitioners: Design and applications

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Abstract

LogMAR charts are particularly useful for visual acuity (VA) measurement for low vision patients as they simplify conversion of non-standard viewing distance visual acuities to standard values. Also, the process of predicting various quantities involved in the prescription of optical devices for patients are greatly facilitated. However, the processes involved in the use of this logMAR principle require series of multiplication and division by the logMAR ratio of 1.2589. A table computed and presented in this article provides easy reference for the conversions and predictions needed for the various quantities at near. The table (Table 1) is computed using the logMAR scale of 1.2589 in logMAR, M and N notations. The table contains VA values between logMAR 1.4 (10M or 80 point) and logMAR 0.18 (1.3M or10 point) in steps of 1.2589 for reduced (non-standard) viewing distances ranging from 31.8 cm (0.32 m) to 3.2 cm (0.03M). The table contains values which can be used to convert visual acuity values measured at reduced near viewing distances to standard visual acuity values. The values also can be used to represent any of the quantities involved in the prescription of optical devices for low vision patients. The use of the table for converting reduced distance VA values to standard values and for predicting optical powers and visual performance of low vision patients are discussed with relevant examples. Like all principles based on the logMAR principles, the table is quite versatile in VA conversion and prediction of the various quantities such as print size that can be read by the low vision patient when factors such as viewing distance or power are varied.

Keywords: Conversion table, logMAR, near visual acuity, low vision, magnifiers, print sizes.

Introduction

A common presenting goal of low vision patients is to be able to perform near tasks such as reading[1, 2]. Distance and near visual acuity values have been recommended for calculating magnifying powers needed by low vision patients for near tasks[3-6] and are still being used by many clinicians. The use of conventional acuity, especially the distance values has, however, been criticized for not being ideal for reading power calculation[7, 8]. Patients with low vision do not show a close relationship between the threshold visual angle for isolated capital letters and for continuous text, therefore conventional tests of acuity are of little use in predicting the magnification that the patient

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Received 20 June 2006; revised version accepted 9 December 2006

needs to read with reasonable speed and accuracy[7]. Also, printed material presents a more complex and difficult task than does acuity letters; there is often poor agreement between reading acuity and distance letter acuity and these discrepancies become most pronounced when there is a disturbance of macular function as in macular degeneration and amblyopia[8].

Although, Snellen acuity charts are still being used by many clinicians worldwide for examination of both normally and visually impaired patients, the use of logMAR charts are preferable. The advantages of these charts over the Snellen ones for routing clinical and research work have been discussed by several authors[9 - 14]. The use of logMAR acuity, word reading or continuous sentences offer greater advantages for examination and prescription of optical devices for low vision patients.

For calculation of magnification power for near tasks, there are several methods that are being used. One of these is the ratio of the print size that the patient can read and the estimated print size that he or she would like to read. For example, if a patient can read print of 5M at a specific distance; to read print of 2.5M at the same distance will require magnification of 5/2.5 = 2x. Another method is the use of 1M as a direct measure of required dioptric power of the reading magnifier[7]. If a patient is able

Table 1. The applications and advantages of the table

SVD/ VA	NON-STANDARD VIEWING DISTANCES (LogMAR / M / N) ADJUSTED VISUAL ACUITY (LogMAR / M / N)										
40 cm 0.4 M	32 0.32	25 0.25	20.0 0.20	16.0 0.16	12.7 0.13	10.0 0.10	8.0 0.08	6.3 0.06	5.0 0.06	4.0 0.04	3.2 0.03
1.4 10 80	1.11 8 64	0.9 6.3 51	0.7 5 40	0.6 4 32	0.44 3.2 25	0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6
1.1 8 64	0.9 6.3 51	0.7 5 40	0.6 4 32	0.44 3.2 25	0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5
0.9 6.3 51	0.7 5 40	0.6 4 32	0.44 3.2 25	0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4
0.7 5 40	0.6 4 32	0.44 3.2 25	0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32
0.6 4 32	0.44 3.2 25	0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32	0.05 0.32 2.5
0.44 3.2 25	0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32	0.05 0.32 2.5	0.04 0.26 2
0.35 2.5 20	0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32	0.05 0.32 2.5	0.04 0.26 2	0.03 0.20 1.6
0.3 2 16	0.22 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32	0.05 0.32 2.5	0.04 0.26 2	0.03 0.20 1.6	0.02 0.16 1.3
0.2 1.6 13	0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32	0.05 0.32 2.5	0.04 0.26 2	0.03 0.20 1.6	0.02 0.16 1.3	0.0016 0.13 1
0.18 1.3 10	0.14 1 8	0.11 0.8 6	0.1 0.64 5	0.07 0.52 4	0.06 4 32	0.05 0.32 2.5	0.04 0.26 2	0.03 0.20 1.6	0.02 0.16 1.3	0.0016 0.13 1	0.012 0.10 0.8

to read certain M units at 40 cm, the reading ability in M units times 2.5 D is equal to the power of the required magnifier. For example, if a patient can read 6M at 40 cm and he or she wishes to read 1M, the power required will be 2.5 X 6 = +15.00 D. Although these and other methods are still in use today, the use of the logMAR principle greatly facilitates the process of evaluation and prescription of devices for low vision patients as described below.

During the examination of a low vision patient, it is often necessary to reduce the viewing distance to enable the patient to read a particular print size or to read smaller print size on the chart. In this situation, the print meant to be read at the standard near viewing distance of 40 cm may be presented to the patient at a reduced distance such as 16 cm. Subsequently, the VA value may need to be converted to standard viewing distance (40 cm) value. If a logMAR chart is used for the VA measurement, the conversion is quite simple, provided that appropriate reduction in viewing distance in steps of 1.2589 is employed. The ease of conversion of the non-standard VA values to standard value is an important feature of the logMAR principle. The process, however, involves series of multiplication and division of viewing distances by logMAR ratio of 1.2589. The process can, however, be made easy by the use of a conversion table. A conversion table for distance VA has been computed and described in a previous article[14]. In this article, the computation of a near conversion table (Table 1) and its applications are described.

Method

The table was computed using the logMAR scale of 1.2589 in logMAR, M and N notations. The table contains VA values between logMAR 1.4 (10M or N80) and logMAR 0.18 (1.3M or N10) in steps of 1.2589 for reduced (non-standard) viewing distances ranging from 31.8 cm (0.32 m) to 3.2 cm (0.03 m). The VA values corresponding to the VA at reduced distances were calculated and presented in the table. The various values shown in the table can be used appropriately to represent other quantities such as power, viewing distance, magnification *et cetera* in the various calculations for low vision patients. The actual table will be produced in an A3 size for easy reference.

The applications and advantages of the table

One of the uses of the table is to convert non-standard viewing distance to standard value. The following examples will illustrate the uses and advantages of the table in this regard:

Example 1: A patient reads 0.7 logMAR (5M or N40) at a reduced distance of 20 cm. What is the equivalent value of this VA at the standard viewing distance of 40 cm? By dividing 40 cm by 1.2589 three times, we would arrive at 20 cm. This shows that the viewing distance has been reduced by a factor of 3 logMAR steps. Therefore, the VA at standard viewing distance will be three logMAR steps larger print. This can be calculated by multiplying 0.7 logMAR (5M or N40) three times by 1.2589. The VA will then be logMAR 1.4 (10M or N80). The use of the table helps to avoid these divisions and multiplications. Referring to the table, it can be seen that 20 cm is 3 steps from 40 cm (row 1). The practitioner can therefore, simply move three steps from 0.7 logMAR (5M or 40 point) to logMAR 1.4 (10M or N80) on the standard viewing distance column 1.

Conversely, if a patient can read logMAR 1.4 (10M or N80) at 40 cm, what will he be able to read if the viewing distance is reduced to 20 cm? The examiner needs to calculate how many steps that the viewing distance has been reduced in order to predict how many steps the patient will read down the chart. Calculation will reveal three logMAR steps in viewing distance reduction. Therefore, the patient will be expected to read three logMAR steps down the chart. This will need to be calculated by dividing logMAR 1.4 (10M or N80) three times which leads to logMAR 0.7 (5M or N40). Using the table, 40 cm (row 1) to 20 cm (row 4) is three logMAR steps, therefore, moving three steps down column 1 from logMAR 1.4 (10M or N80) will lead to 0.7 logMAR (5M or 40 point), which is the VA that the patient will be expected to read at 20 cm. The multiplication and division processes involved are even more demanding if the difference between the standard viewing distance and reduced viewing distance is high as shown in example 2.

Example 2: A patient can read logMAR 0.1 (0.64M or N5) at 5 cm. What is the equivalent value of his or her visual acuity at the standard viewing distance of 40 cm? By calculation, dividing 40 cm by 1.2589 nine times will lead to 5 cm. This implies that the reduction in viewing distance is 9 logMAR steps. The equivalent VA value will be nine logMAR steps larger prints on the chart. This will be calculated by multiplying logMAR 0.1 (0.64M or N5) by 1.2589 nine times, a process that will lead to logMAR 0.7 (5M or N40). The use of the table presented here greatly simplifies this process. The clinician simply needs to locate 5 cm in row 1, column 10, then identify logMAR 0.1 (0.64M or N5) in that column on row 5. He or she can then read the corresponding value on column 1, row 5, which in this case is logMAR 0.7 (5M or N40) Conversely, if a patient can read logMAR 0.7 (5M) and N40 at 40 cm; what will he or she be expected to read at 5 cm?. The clinician simply needs to identify logMAR 0.7 (5M or N40) on column 1, row 5, and follow the row to logMAR 0.1 (0.64M or N5) in column 10 where 5 cm is located, which is quite easy and faster than the calculation method.

Another important feature of the logMAR near charts in relation to low vision care is that the quantities involved in the optical prescriptions for near vision are proportional to one another. The angular subtense of a print is inversely proportional to the viewing distance and the dioptric power of the near addition is inversely proportional to the focal distance of the lens. Also, the magnification provided by a device is directly proportional the dioptric power and the threshold print size is inversely proportional to the magnification used or directly proportional to the viewing distance and so on[15]. Because of these features, the logMAR reading charts can be used to predict optical needs and performance of a patient with an optical device of known power. The use of the table presented in this article facilitates these various conversions. The following examples illustrate the use and advantages of the conversion / prediction table.

Powers and focal lengths of magnifiers are particularly important in low vision care because magnifying lenses are high power plus lenses. Consequently, their foci are very important because, if the patient does not look through these, clear vision will not be possible. The use of this reference table in low vision care to predict focal lengths or viewing distances for devices such as spectacle magnifiers can be explained as follows:

Example 3: A patient, who previously used a magnifier of +8.00 D, has the power of his prescription increased to +20.00 D due to increase in visual demand. What will be the viewing distance for the new device? Calculation will show that the change in power is four logMAR steps. Therefore, the viewing distance will reduce by four logMAR steps. Calculation will therefore show viewing distance change from 12.5 to 5 cm. From the table (row 1 can be used), from 8.0 to 20 (representing powers) is four steps upward shift in the logMAR scale. The focal length (viewing distance) will also change (reduce) by four logMAR step from 12.5 cm (for +8.00 D) to 5 cm (row 1 column 10 on the Table 1) for the new power. This implies that, if the dioptric power of the magnifier required by the patient is increased by a certain logMAR ratio, the viewing distance (focal distance of the lens) will need to be reduced by the same ratio for the patient to see the print in focus. The various calculations involved can be bypassed by using the table.

Direct proportionality of the magnification with dioptric power is important in low vision care because, as power is increased, it may be necessary to know the magnification that will be provided for the patient. The use of the table in this case can be explained by the following example:

Example 4: A patient has a magnifier which provided magnification of 2x; if it is anticipated that, due to change in visual need, the patient will now benefit from a magnification of 4x. Without calculation, power needed can be read from the table as follows. The magnification has increased by three logMAR steps; therefore the power of the device will need to increase by the same factor. Calculation will show that the power will change +8.00D to +16.00 D. Using the table (row one) shows that three logMAR steps from 8 will lead to 16 which is what calculations will reveal. Therefore, if the ratio of increase or decrease in magnification required is known, the dioptric power needed will just be an increase in ratio of the original dioptric power and can be read directly from the table.

The table can also be used to predict the print size that a patient is expected to read when the dioptric power of the magnifier is known or changes.

Example 5: Suppose a patient can read logMAR 0.6 (4M or N32) at 40 cm with a magnifier of power +5.00D. If the clinician decides to increase the power to +8.00 D, what print size is the patient expected to read? The change in power is 2 steps increase on the logMAR scale (row 1). The patient will therefore, be expected to read 2 steps down the logMAR chart (column 1 of the table), which calculation will show to be 0.35 logMAR (2.5M or N20). These can be read directly on the table. Two steps (column one) from logMAR 0.6 (4M or N32) will lead to 0.35 logMAR (2.5M or N20). Similarly, the power of magnifier needed by a patient to read a particular print can be calculated easily by moving in appropriate steps on the logMAR scale of the table if the change in print size is known.

The direct proportionality of print size and viewing distance using the logMAR chart and the table can be explained as follows: As the viewing distance is reduced, the angular subtense of the print increases correspondingly (relative distance magnification), therefore the patient will be expected to read smaller print size which corresponds to the number of logMAR steps by which the viewing distance has been reduced as shown in the following example:

Example 6: A patient can read 6.3M (0.9 logMAR or N51) at 25 cm. If it is anticipated that the patient will achieve her visual goal if she is able to read 2M (0.3 logMAR or N16) print size at the same distance. Using the principle of relative distance magnification, what reduction in viewing distance will make this possible? By calculation, the reduction in the print size is 5 logMAR steps. Decreasing the viewing distance by a factor of 5 logMAR steps by calculation from 25 cm will lead to 8 cm (row 1 of the table). This will afford the visual resolution needed by the patient to read the print. The clinician using the table simply has to count how many steps from 6.3M (0.9 logMAR or N51) (from anywhere in the table e.g. second row) will lead him or her to 2M (0.3 logMAR or N16). This will be five steps. He or she can then reduce the viewing distance by the same ratio from 25 cm to 8 cm, which is the required viewing distance.

Example 7: If a patient can read 1.4 logMAR (10M or N80) at 40 cm and the viewing distance is reduced to 20 cm; what print size is the patient expected to read? By calculation, the reduction in viewing distance represents 3 logMAR steps. The patient will therefore be expected to read 3 steps on the smaller prints on the chart, which will be 0.7 logMAR (5M) (N40) by calculation. Using the table, from 40 to 20 is three logMAR steps (row 1). A three step on the first column of the table from 1.4 logMAR (10M or N80) will lead to 0.7 logMAR (5M or N40). The table can therefore be used easily to predict the change in print size to be read when the viewing distance in reduced by certain logMAR ratio steps.

Conclusion

Because of the various predictions afforded by the logMAR principle, the use of logMAR near chart can be used to estimate the print size that a patient would resolve if the working distance or dioptric power of the device was changed appropriately[15]. The table described in this article affords easy reference for all the calculations that the low vision practitioner may wish to do regarding conversion of non-standard viewing distance visual acuities to standard values and predicting quantities resulting from changes such as viewing distance, print sizes, dioptric powers *et cetera* during low vision patient assessment and in the prescription of magnifying powers. The table is versatile as it can be applied to various quantities such as powers (diopters), focal lengths, magnification, print sizes (mm, cm, and inches), changes in viewing distances, changes in angular size *et cetera*. Also, the rows and columns can be used interchangeably where relevant values are available.

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