Article • Visual Acuity Assessment with a DYOP Versus a Snellen Acuity Chart for Pre- and Post-Cataract Surgery

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ABSTRACT

Purpose: To compare the visual acuity of pre- and post-cataract surgery patients using a Snellen and Dyop acuity chart as to differences in resolution versus recognition acuity.

Methods: Fifty-nine patients (105 eyes) with senile cataracts, aged 40 years or older and with no other ocular pathologies, were evaluated as to visual acuity for pre- and post-cataract surgery using the Snellen and Dyop acuity charts.

Results: Pre-surgery cataracts were nuclear in 50 eyes; nuclear and posterior subcapsular in 24 eyes; nuclear and cortical in 23 eyes; nuclear, cortical, and posterior subcapsular in 4 eyes; and nuclear, anterior, and posterior subcortical in 2 eyes. The average spherical equivalents from pre-cataract surgery refractive assessments for the patients were -0.61±2.81D and -0.63±3.22D for right and left eyes, respectively. The mean VA measured prior to cataract surgery was significantly overestimated with Snellen (OD: 0.64±0.15, OS: 0.69±0.23 decimal units) versus Dyop (OD: 0.53±0.25, OS: 0.55±0.24 decimal units) for both eyes (OD: p=0.01, OS: p=0.01). The mean VA measured following cataract surgery was also significantly overestimated with Snellen (OD: 0.88±0.22, OS: 0.85±0.20 decimal units) versus Dyop (OD: 0.72±0.22, OS: 0.72±0.23 decimal units) for both eyes (OD: p=0.00, OS: p=0.01). The Bland Altman plots of difference in the means for assessment of visual acuity with the two charts against the average means for assessment of visual acuity with the two charts for both eyes showed no agreements for the two pre- and post-cataract surgery.

Conclusions: Visual acuity measurements pre- and post-cataract surgery were different with a Snellen and a Dyop acuity chart in that the Dyop test was a more precise indicator of acuity resolution. These two charts cannot be used interchangeably. The apparent strength of the Dyop acuity assessment is that it primarily uses resolution acuity, thus preventing overestimation of visual acuity, which is inherent in the recognition acuity of the Snellen test.

Keywords: age-related cataract, cataract surgery, Dyop acuity chart, Snellen acuity chart, visual acuity, visual acuity charts

Introduction

Visual acuity (VA) measurement with different charts is the conventional and standard test of visual function in patients with cataracts. Visual acuity depends on factors like luminance, contrast, spectral distribution, age, and visual adaptation. Its simple measurement can reveal many visual disorders. Cataracts seem to potentiate intraocular light scatter, which affects visual acuity in patients with cataracts. In general, the principles employed in designing the charts are based on common optical and physiological parameters, and the only difference in charts is related to their design type and measurement accuracy.[1]

In 1862, Dr. Hermann Snellen invented an acuity chart that became the standard for measurement of visual acuity in clinical practice because of its accessibility and easy and quick procedure in assessing recognition of letters (Figure 1). The Snellen acuity chart is the most common chart in the world, having a large letter on top, with the number of letters increasing from the top to the bottom of the chart.[2] However, it has been established that the

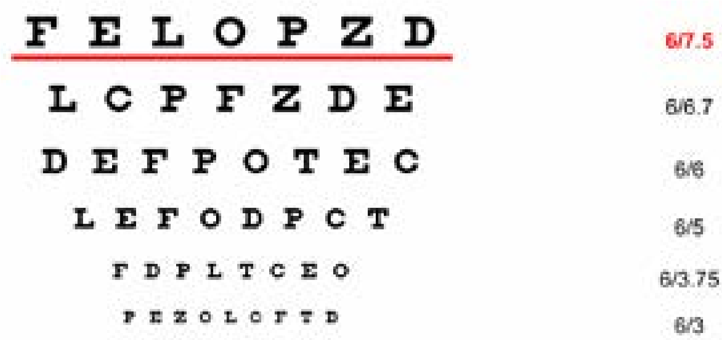

Figure 1. *Computerized Snellen acuity chart, Source; Chart2020® Version 10.3.6.*

combination of an irregular progression of letter sizes down the chart, the differing number of letters comprising each chart line, and the mixed relative legibility of the letters chosen together compromise the accuracy of conventional VA determination; the typical test circumstances also prohibit statistical analysis of VA data.[3]

In 2008, Allan Hytowitz invented a uniformly spinning segmented ring, which appears as a binary strobic dynamic optotype, or Dyop (Figure 2).[4] A Dyop can be used as an acuity test for infants, non-literate patients, and non-verbal individuals because its mechanism of assessment of visual acuity is not based on the cultural cognition of letters as an optotype.[5] The smallest angular arc width diameter of a Dyop that can be detected as spinning is the indicator of acuity, as well as the acuity and refraction endpoint whose values are comparable to static Snellen-type optotypes. Those Snellen feet, Snellen meters, LogMAR, and decimal comparisons are included in the display of Dyop arc widths.

The design of a Dyop visual target combines angular arc width, segment stroke width, rotation speed (rotations per minute), segment contrast, segment

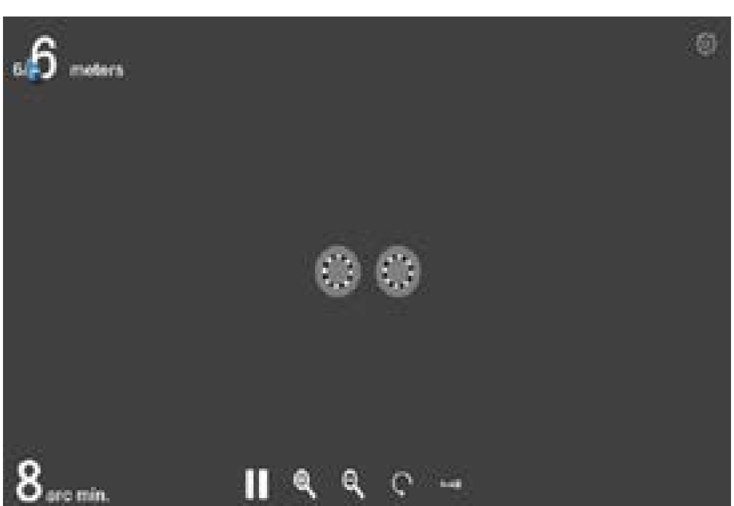

Figure 2. *A Computerized Dyop acuity chart. Source; Chart2020® Version 10.3.6 Computerized Visual Acuity Unit.*

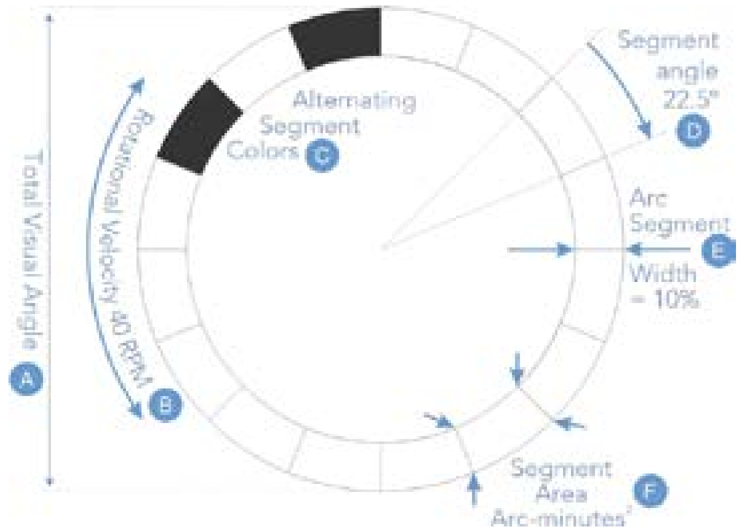

Figure 3. *This illustrates the fundamental features of the Dyop (dynamic optotype) acuity chart: the total circular diameter or arc width visual angle (A), speed of rotation (B), contrasting colors (in this illustration) of black and white (C), segment angle (D), segment arc width (E), and area of each segment (F) in minutes squared of arc.*[7]

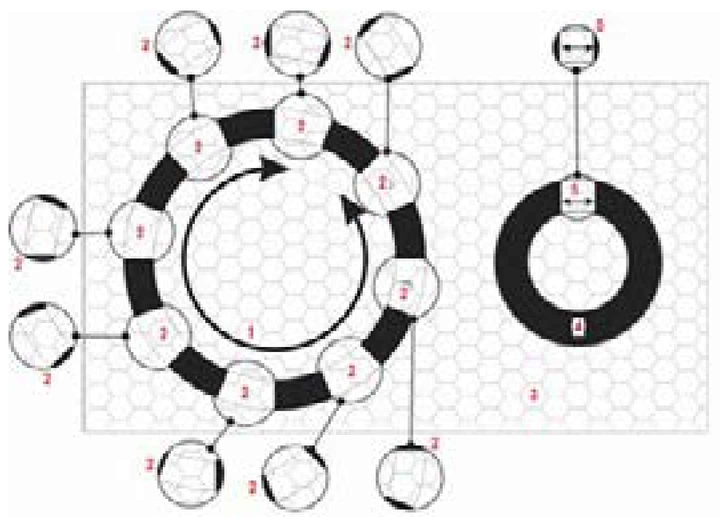

Figure 4. *Display of the moving segmented areas of a Dyop and the resultant moving, stimulated individual areas superimposed on the retina*
Item 1 – visual angular velocity or strobic contrast response
Item 2 – a moving segment visual arc-area dynamically stimulating retina cells with motion
Item 3 – retinal cells
Item 4 – an example of a static historical optotype
Item 5 – a static minimum angle of resolution of a historical optotype

color, and the pixelized strobic photoreceptor refresh rate of the spinning segmented ring to create an acuity threshold as an indicator for the measurement of visual acuity and the functional parameters for determining perception and refractions (Figure 3). The Dyop acuity chart typically, and optimally, uses a circular segmented ring consisting of 8 black and 8 white, equal-sized, alternating segments on a neutral gray background, spinning at 40 rotations per minute, with a 10% stroke width (Figure 4).[6]

Table 1. Clinical Characteristics of 59 Subjects Undergoing Cataract Surgery

Type of Cataract	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Nuclear sclerosis	24	44.4	26	53.1
Nuclear sclerosis and posterior subcapsular	15	27.8	9	18.4
Nuclear sclerosis and cortical	14	25.9	9	18.4
Nuclear sclerosis, cortical, and posterior subcapsular	1	1.9	3	6.1
Nuclear sclerosis, anterior and posterior subcapsular	0	0	2	4.1

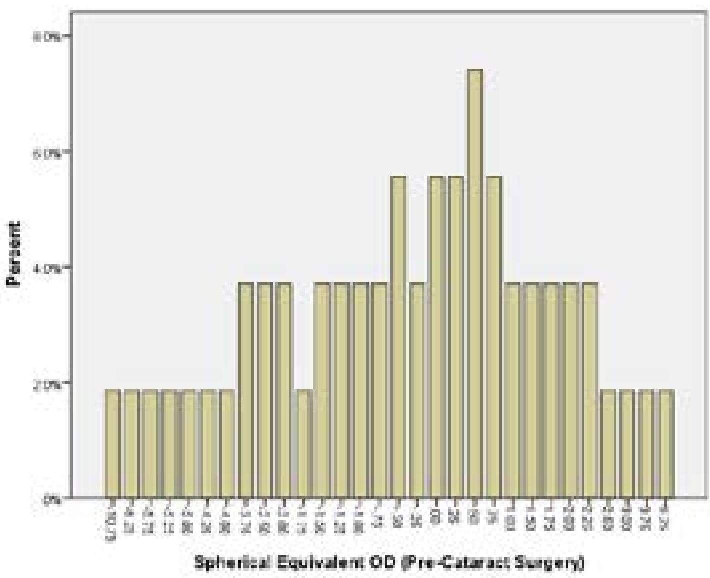

Figure 5. *The spherical equivalent refractive assessment pre- cataract surgery for the right eye of the subjects*

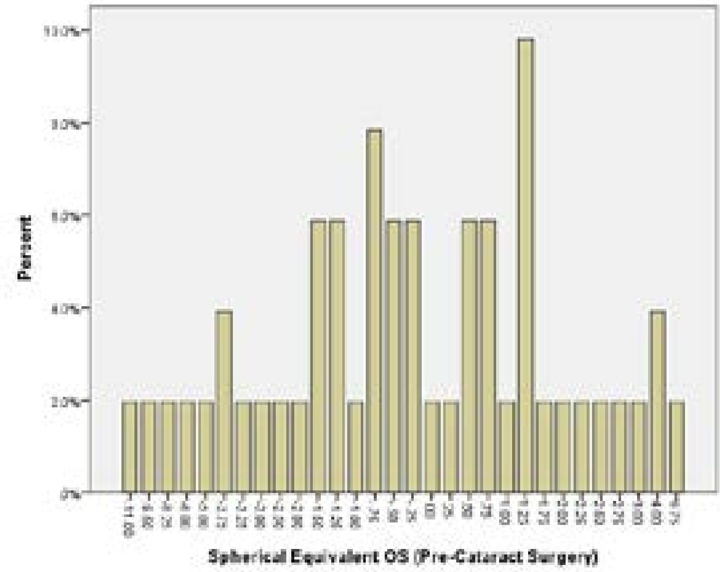

Figure 6. *The spherical equivalent refractive assessment pre-cataract surgery for the left eye of the subjects*

Patients and Methods

Fifty-nine patients were selected from participants of an ongoing descriptive study on the natural history of age-related cataracts at the Eye Physicians and Surgeons practice in Decatur, Georgia. Patients aged 40 years or older with no ocular diseases other than cataracts (such as glaucoma, optic nerve disease, macular diseases, or anterior segment disease) were enrolled for the study. All subjects had at least one eye with a single type of cataract (pure cortical, pure nuclear, or pure posterior subcapsular). Each patient underwent a complete ophthalmologic and optometric eye examination. Visual acuity was determined monocularly and reported as a Snellen ratio using the Snellen and Dyop acuity charts both pre- and post-cataract surgery. The visual acuity measurements were then converted to equivalent decimal notations.

Data Collection and Statistical Analysis

This study was analyzed using Statistical package for Social Science (SPSS) version 24.0:

i. The clinical characteristics of patients undergoing cataract surgery were assessed.

ii. The difference between the visual acuity assessment obtained using the two acuity charts was determined with paired t-test and Bland Altman plot at 95% limit of agreement (95% LoA).

Results

Fifty-nine subjects (105 eyes, OD: 54 eyes and OS: 51 eyes) were recruited for pre- and post-cataract surgery visual acuity assessment using Snellen and Dyop acuity charts (Table 1). An estimate of 44.4% (n=24) of the right eyes were diagnosed with nuclear sclerosis; 27.8% (n=15) had nuclear sclerosis and posterior subcapsular cataract; 25.9% (n=14) had nuclear sclerosis and cortical cataract; and 1.9% (n=1) had nuclear sclerosis, cortical, and posterior subcapsular cataract. An estimate of 53.1% (n=26) of the left eyes were diagnosed with nuclear sclerosis; 18.4% (n=9) had nuclear sclerosis and posterior subcapsular cataract; 18.4% (n=9) had nuclear sclerosis and cortical cataract; 6.1% (n=3) had nuclear sclerosis, cortical, and posterior subcapsular cataract; and 4.1% (n=2) were diagnosed with nuclear sclerosis, anterior, and posterior subcapsular cataract. The average spherical equivalent pre-cataract surgery refractive assessments for the subjects were -0.61±2.81D and

-0.63±3.22D for the right and left eyes, respectively (Figure 5 and Figure 6).

Snellen Acuity Chart Pre- and Post-Cataract Assessment

Using decimal notation to represent the Snellen ratio, a paired t-test was carried out to compare the visual acuity assessed pre- and post-cataract surgery using a Snellen acuity chart. The results are shown in Table 2. The difference between the pre-cataract surgery mean VA for the right eye (0.64±0.15 decimal units) and the post-cataract surgery mean VA for the right eye (0.88±0.22 decimal units) assessed with a Snellen acuity chart was statistically significant (p=0.00). The difference between the pre-cataract surgery mean VA for the left eye (0.69±0.23 decimal units) and the post-cataract surgery mean VA for the left eye (0.85±0.20 decimal units) assessed with a Snellen acuity chart was also statistically significant (p=0.01). This indicates that there was a significant difference (p<0.05) in the VA of the subjects assessed with a Snellen acuity chart pre- and post-cataract surgery.

From this result, it can be inferred that there was clinically significant improvement (which could not have occurred by chance) in subjects' visual acuity following cataract surgery when compared to their pre-cataract surgery visual acuity assessment with Snellen acuity charts.

Dyop Acuity Chart Pre- and Post-Cataract Assessment

The results of a paired t-test carried out to compare the visual acuity assessed pre- and post-cataract surgery using a Dyop acuity chart are shown in Table 3. The difference between the pre-cataract surgery mean VA for the right eye (0.53±0.25 decimal units) and the post-cataract surgery mean VA for the right eye (0.71±0.22 decimal units) assessed with a Dyop acuity chart was statistically significant (p=0.00). The difference between the pre-cataract surgery mean VA for the left eye (0.69±0.23 decimal units) and the post-cataract surgery mean VA for the left eye (0.85±0.20 decimal units) assessed with a Dyop acuity chart was also statistically significant (p=0.02). This means that there was a significant difference (p<0.05) in the visual acuity of the subjects assessed with a Dyop acuity chart pre- and post-cataract surgery.

From this result, it can be inferred that there was clinically significant improvement (which could not have occurred by chance) in subjects' visual acuity following cataract surgery when compared to their pre-cataract surgery visual acuity assessment with Dyop acuity charts.

Snellen versus Dyop Pre-Cataract Assessment

The results of a paired t-test carried out to compare the pre-cataract surgery visual acuity using the two charts is shown in Table 4. The difference between the pre-cataract surgery mean VA for the right eye measured with Snellen (0.64±0.15 decimal units) and Dyop (0.53±0.25 decimal units) tests was statistically significant (p=0.01). The difference between the pre-cataract surgery mean VA for the left eye assessed with Snellen (0.69±0.23 decimal units) and Dyop (0.55±0.24 decimal units) tests was also statistically significant (p=0.01). This means that there was a significant difference (p<0.05) in the subjects' visual acuity assessed with a Snellen acuity chart as compared to a Dyop acuity chart.

Table 2. Paired t-test Findings for VA Assessed Pre- and Post-Cataract Surgery with a Snellen Acuity Chart

Variables	N	Mean VA +/- SD	p-value
Snellen VA pre-cataract surgery, right eye	27	0.64 +/- 0.15	0.00
Snellen VA post-cataract surgery, right eye	27	0.88 +/- 0.22	
Snellen VA pre-cataract surgery, left eye	25	0.69 +/- 0.23	0.01
Snellen VA post-cataract surgery, left eye	25	0.85 +/- 0.20	

Table 3. Paired t-test Findings for VA Assessed Pre- and Post-Cataract Surgery with a Dyop Acuity Chart

Variables	N	Mean VA +/- SD	p-value
Dyop VA pre-cataract surgery, right eye	26	0.53 +/- 0.25	0.00
Dyop VA post-cataract surgery, right eye	26	0.71 +/- 0.22	
Dyop VA pre-cataract surgery, left eye	24	0.55 +/- 0.24	0.02
Dyop VA post-cataract surgery, left eye	24	0.72 +/- 0.23	

Table 4. Paired t-test Findings for VA Assessed Pre-Cataract Surgery Using the Two Charts

Variables	N	Mean VA +/- SD	p-value
Snellen VA right eye	27	0.64 +/- 0.15	0.01
Dyop VA right eye	27	0.53 +/- 0.25	
Snellen VA left eye	25	0.69 +/- 0.23	0.01
Dyop VA left eye	25	0.55 +/- 0.24	

Table 5. Paired t-test Findings for VA Assessed Post-Cataract Surgery Using the Two Charts

Variables	N	Mean VA +/- SD	p-value
Snellen VA right eye	26	0.88 +/- 0.22	0.00
Dyop VA right eye	26	0.72 +/- 0.22	
Snellen VA left eye	24	0.85 +/- 0.20	0.01
Dyop VA left eye	24	0.72 +/- 0.23	

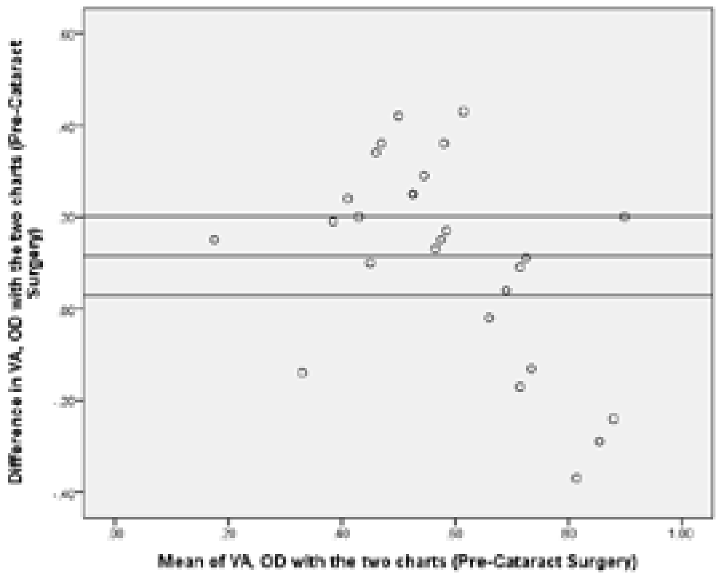

Figure 7. *Bland Altman plot showing the limit of agreement between the visual acuity assessments using the two charts pre-cataract surgery for the right eye*

From this result, it can be inferred that the assessment of visual acuity with a Snellen acuity chart is distinctive from assessment with a Dyop acuity chart pre-cataract surgery.

Snellen versus Dyop Post-Cataract Surgery Assessment

The results of a paired t-test carried out to compare the visual acuity assessed post-cataract surgery using the two charts is shown in Table 5. The difference between the post-cataract surgery mean VA for the right eye measured with Snellen (0.88±0.22 decimal units) and Dyop (0.72±0.22 decimal units) tests was statistically significant ($p=0.00$). The difference between the post-cataract surgery mean VA for the left eye assessed with Snellen (0.85±0.20 decimal units) and Dyop (0.72±decimal units) tests was also statistically significant ($p=0.01$). This means that there was a significant difference ($p<0.05$) in the visual acuity of the subjects assessed with a Snellen acuity chart as compared to a Dyop acuity chart.

From this result, it can be inferred that the assessment of visual acuity with a Snellen acuity chart is distinctive from assessment with a Dyop acuity chart post-cataract surgery.

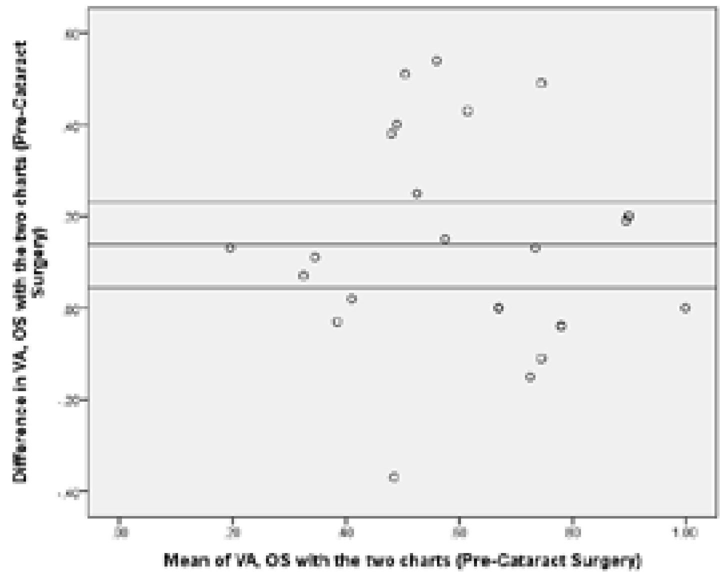

Figure 8. *Bland Altman plot showing the limit of agreement between the visual acuity assessments using the two charts pre-cataract surgery for the left eye*

Limit of Agreement for Right Eye Pre-Cataract VA Comparison

The mean difference between assessment of visual acuity with Snellen and Dyop acuity charts for the right eye was 0.12±0.22 decimal units, with the upper and lower limits of agreement at 0.03 and 0.20, respectively. The Bland Altman plots of difference in the means for assessment of visual acuity with the two charts against the average means for assessment of visual acuity with the two charts for right eyes showed that more than 50% of the values lay outside the limit, which indicated that there was no agreement between the tests, as seen in Figure 7.

Limit of Agreement for Left Eye Pre-Cataract VA Comparison

The mean difference between assessment of visual acuity with Snellen and Dyop acuity charts for the left eye was 0.14±0.23 decimal units, with the upper and lower limits of agreement at 0.04 and 0.23, respectively. The Bland Altman plots of difference in the means for assessment of visual acuity with the two charts against the average means for assessment of visual acuity with the two charts for left eyes also showed that more than half of the points lay outside the limit, which indicated that there was no agreement between the tests, as seen in Figure 8.

Limit of Agreement for Right Eye Post-Cataract VA Comparison

The mean difference between assessment of visual acuity with Snellen and Dyop acuity charts for the right eye was 0.17±0.23 decimal units, with the upper and lower limits of agreement at 0.08 and 0.26, respectively. The Bland Altman plots of difference in

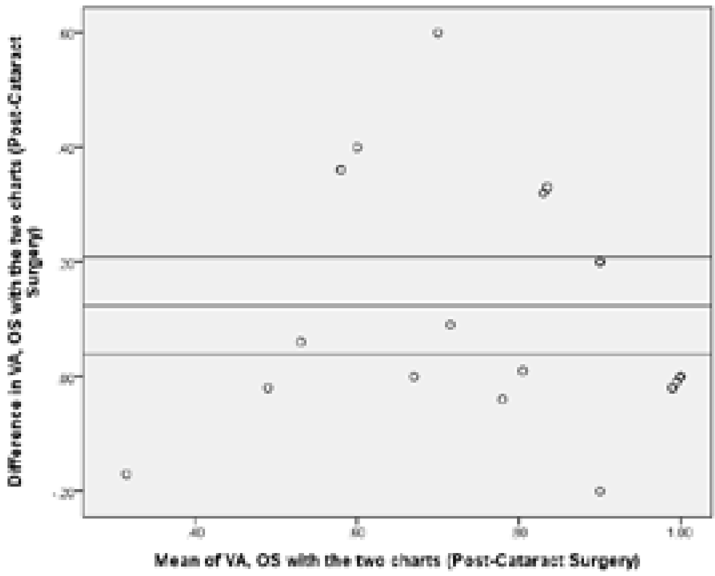

Figure 9. *Bland Altman plot showing the limit of agreement between the visual acuity assessments using the two charts post-cataract surgery for the right eye*

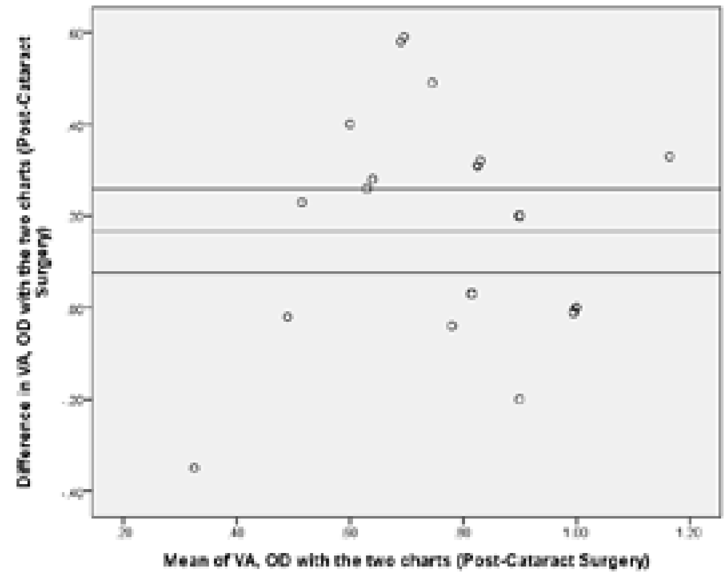

Figure 10. *Bland Altman plot showing the limit of agreement between the visual acuity assessments using the two charts post-cataract surgery for the right eye*

the means for assessment of visual acuity with the two charts against the average means for assessment of visual acuity with the two charts for right eyes revealed that majority of the points lay outside the limit, which indicated that there was no agreement between the tests, as seen in Figure 9.

Limit of Agreement for Left Eye Post-Cataract VA Comparison

The mean difference between assessment of visual acuity with Snellen and Dyop acuity charts for the left eye was 0.12±0.20 decimal units, with the upper and lower limits of agreement at 0.04 and 0.21, respectively. The Bland Altman plots of difference in the means for assessment of visual acuity with the two charts against the average means for assessment of visual acuity with the two charts for left eyes showed that most of the values lay outside the limit, which indicated that there was no agreement between the tests, as seen in Figure 10.

Discussion

Considerable research has been done to evaluate the effect of cataract surgery on the restoration of vision because the incidence of cataracts constitutes 5% of blindness in Western Europe and approximately 50% in developing countries.[8] However, in this study, we evaluated the comparison between the visual acuity assessed pre- and post-cataract surgery using the recognition acuity of a Snellen acuity chart and the resolution acuity of a Dyop acuity chart.

An increase in cataract severity is strongly associated with a decrease in VA in the sufferers. A more precise measure of VA assessment in patients with cataracts could help in the objective estimation of the need for cataract surgery prior to surgery and also assess the level of vision restoration post-cataract surgery.[9]

Traditionally, VA in a clinical setting is measured with a letter chart. However, the ability to recognize a letter differs from a resolution task, such as detecting the direction of a spinning segmented ring.[10]

The mean visual acuity (OD: 0.64±0.15 decimal units, $6/9^{-}$; OS: 0.69±0.23 decimal units, $6/9^{+}$) for both eyes assessed pre-cataract surgery with a Snellen chart (recognition acuity) improved significantly (n=27, p=0.00) post-cataract surgery (OD: 0.88±0.22 decimal units, $6/6^{-}$; OS: 0.85±0.20 decimal units, $6/6^{-}$), as shown in Table 2.

Similarly, the mean visual acuity (OD: 0.53±0.25 decimal units, $6/12^{+}$; OS: 0.55±0.24 decimal units, $6/12^{+}$) for both eyes assessed pre-cataract surgery with a Dyop chart (resolution acuity) also improved significantly (n=25, p=0.01) post-cataract surgery (OD: 0.71±0.22 decimal units, $6/9^{+}$; OS: 0.72±0.23 decimal units, $6/9^{+}$), as shown in Table 3. This implies that the post-cataract surgery visual acuity outcomes were in concordance with WHO's recommended levels: >80% of subjects should have unaided visual acuity between 6/6 and 6/18.[8]

In contrast to the above findings, a paired t test showed a significant difference in VA assessed pre-cataract surgery (OD: n=27, p=0.01; OS: n=25, p=0.01) and post-cataract surgery (OD: n=26, p=0.00; OS: n=24, p=0.01) with the Snellen acuity chart and the Dyop acuity chart (Table 4 and Table 5).

In the same vein, the mean difference between assessment of VA pre-cataract surgery with Snellen and Dyop acuity charts was OD: 0.12±0.22 and OS: 0.14±0.23 decimal units, with the upper and lower limits of agreements at OD: 0.03, OS: 0.04 and OD: 0.20, OS: 0.23 for both eyes, respectively (Figure 7 and Figure 8). The mean difference between assessment of VA post-cataract surgery with Snellen and Dyop acuity charts was OD: 0.17±0.23 and OS: 0.12±0.20 decimal units, with the upper and lower limits of agreement at OD: 0.08, OS: 0.04 and OD: 0.26, OS: 0.21 for both eyes, respectively (Figure 9 and Figure 10).

The Bland Altman plots of difference in the means of VA results post-cataract surgery for the two charts used as a function of the average means of VA results showed that the limits of agreement between the two charts for both eyes were not within clinically acceptable levels post-cataract surgery. This implies that there was a proportional bias, a very narrow limit of agreement, and/or that more than half of the points on the plots[12] were outliers in the two directions, outside the two limits or standard deviations from the center. Hence, there was no agreement between the two charts as to the assessment of VA of the subjects. This further implies that the two charts were distinctive in VA assessment post-cataract surgery, and the findings from the two charts cannot be used interchangeably.

A paired t test indicated a significant difference in VA in the subjects pre- and post-cataract surgery; i.e., the mean VA for both eyes assessed pre- and post-cataract surgery with a Snellen acuity chart was overestimated compared to that assessed with a Dyop acuity chart. These findings are similar to those of Becker and Graef,[1] who reported a statistically significant difference in VA assessment between Landolt C and Snellen E acuity in strabismic amblyopic patients. They recruited 100 patients (age 8-90 years, median 60.5 years) with different eye disorders, including 39 with amblyopia due to strabismus, and 13 healthy volunteers (age 18-33 years, median 24 years) were also tested. The mean decimal values for Landolt C and Snellen E acuity were 0.25±0.4 and 0.29±0.4 decimal units, respectively, in the entire group and 0.14±0.8 and 0.16±0.8 decimal units, respectively, for the eyes with strabismic amblyopia. The mean difference between Landolt C and Snellen E acuity was 0.55 lines in the entire group and 0.55 lines for the eyes with strabismic amblyopia, with higher values for the Snellen E in both groups. In the acuity range below 0.1, the mean difference between Landolt C and Snellen E acuity was 0.58 lines for the entire group and 0.58 lines for the eyes with strabismic amblyopia, with higher values for the Snellen E in both groups. They concluded that there was a slight overestimation of VA by the Snellen E compared to the Landolt C, even in strabismic amblyopia.

Wittich et al.[10] also investigated the differences between recognition (ETDRS chart) and resolution (Landolt C chart) acuity in 23 patients (age range, 52-82 years) undergoing macular hole surgery. They reported that resolution acuity was significantly more impaired pre- and post-macular hole surgery than recognition acuity (p<0.001), and the limits of agreement between the two acuity types indicated that resolution acuity differed from recognition acuity by up to five lines before surgery and up to three lines after surgery. They concluded that measuring recognition acuity by reading letters may lead to an overestimation of visual ability at the retinal level in patients with macular hole by including compensatory top-down cognitive processes that are unavailable for resolution tasks.

Kaiser[11] criticized the design features of the Snellen chart when he did a comparison between VA scores obtained with Snellen charts and Early Treatment Diabetic Retinopathy Study (ETDRS) charts in 163 eyes. He reported that the Snellen chart design features have a functional deficiency due to the rows of letters of dissimilar length and the irregular and arbitrary progression of letter sizes between lines, which leads to overestimation of vision at the lower end of acuities. The Snellen test also had letters of differing legibility, large test-retest variability (varying from ±5 to 16.5 letters in normal subjects), and up to 3.3 lines in cataractous, pseudophakic, or early-stage glaucoma patients (i.e., a person could have up to a 3.5-line change in vision that may not represent true change or a 2-line discrepancy in vision on repeated testing with a Snellen chart). He concluded that VA was significantly better on the ETDRS chart compared to the Snellen chart, and the difference was greatest with poor VA (<20/200) and in patients with exudative age-related macular degeneration.

However, the Dyop acuity chart gives more precise (fewer exaggerations) VA assessments in subjects when compared with the Snellen chart. This is also in line with the study by Harris,[5] who investigated the accuracy of a prototype Dyop triplet acuity chart using 150 participants. He tested them at threshold VA on standard eye charts, which included projected Sloan, computerized Sloan, and Snellen acuity, as well as the older Dyop triplet. The targets were presented using a standard projected-chart letter target viewed on a halogen projector/silvered screen setup or directly viewed on a computer monitor (M&S Technologies Smart System II VA system), or presented as a Dyop acuity chart viewed on a computer monitor. Each of the targets was viewed through four different acuity conditions. The lens power conditions were full correction alone and then with the following lenses placed over the subject's habitual correction: +2.00 OU, +3.00 OU, +4.00 OU. The order was randomized by chart, and within the chart, by lens condition. The results obtained show that plus lens blur did not decrease VA to the same degree on the Dyop target as it did on either the M&S computer-based chart or the projected chart. The statistical variance in VA measurement with the study condition revealed 0.282 and 0.060 for projected Sloan and Dyop triplet, respectively.

Harris and Keim[7] further investigated the accuracy of a Dyop acuity test with 162 participants by assessing the threshold acuities on a fully randomized basis, using Sloan letters and a Dyop doublet with the following test conditions: uncorrected refraction and corrected refraction with +2.00 lens, +3.00 lens, +4.00 lens. There was a very strong linear Pearson correlation between Sloan and Dyop acuity measures, for all of the test conditions for the subjects (Pearson r=0.95; p<0.001). The statistical variance in VA measurement with the study condition revealed 0.193 and 0.035 for a projected Sloan and a Dyop doublet, respectively. The Dyop was found to be a novel method of measuring VA that was strongly associated with, and may offer an improvement in the assessment of, VA compared to Sloan letters. The Dyop was also reported to be advantageous due to the speed at which the threshold acuity endpoint was defined, finer acuity granularity as compared to the typically used acuity "line" steps, and ease of endpoint identification by subjects.

RECOMMENDATIONS

1. Further studies with larger sample size should be done to establish a better evaluation of the two charts in VA assessment of cataractous eyes, pre- and post-surgery.
2. Further studies on repetitive VA measurement with the two charts should be done to evaluate reproducibility and precision of the VA outcomes in cataractous eyes, pre- and post-cataract surgery.
3. Further studies should be done to compare a Dyop acuity chart with other acuity charts in pre- and post-cataract surgery VA assessment.
4. Further studies should be done to compare the Dyop/Snellen acuity charts with driving simulation testing in pre- and post-cataract surgery as to VA assessment.

Conclusion

There was significant improvement in the VA assessed post-cataract surgery, as compared to the initial VA assessment done pre-cataract surgery, using the two charts. However, it was realized that there was a significant overestimation of VA with the Snellen acuity chart as compared to the Dyop acuity assessment, which may be due to the design features (relative imprecision) of the Snellen acuity chart and compensatory top-down cognitive processes in recognition acuity. VA measurements were different with the Snellen and the Dyop acuity charts pre- and post-cataract surgery, and these two charts cannot be used interchangeably. The Dyop test may offer greater precision in its use of resolution acuity versus the subjective recognition of optotypes.

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