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Original research

Comparison of the visual acuity after photorefractive keratectomy using Early Treatment Diabetic Retinopathy Study Chart and E-chart

Saeedeh Ghorbanhosseini [a], Hassan Hashemi [a,b], Ebrahim Jafarzadehpur [a,c,*], Abbasali Yekta [d], Mehdi Khabazkhoob [e]

[a] *Noor Research Center for Ophthalmic Epidemiology, Noor Eye Hospital, Tehran, Iran*
[b] *Noor Ophthalmology Research Center, Noor Eye Hospital, Tehran, Iran*
[c] *Department of Optometry, Iran University of Medical Sciences, Tehran, Iran*
[d] *Department of Optometry, School of Paramedical Sciences, Mashhad University of Medical Sciences, Mashhad, Iran*
[e] *Department of Medical Surgical Nursing, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

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Abstract

Purpose: To compare the visual responses of post refractive surgery's patients using Early Treatment Diabetic Retinopathy Study Chart (ETDRS) and E-chart with and without color filters.
Methods: The uncorrected Log MAR VA (Logarithm of the Minimum Angle of Resolution Visual Acuity) of 70 patients with a mean age of 26.2 ± 3.76 years (from 19 to 34 years) who had undergone PRK (Photorefractive Keratectomy eye surgery) (the range of post operation refractive error: ±0.5 D) was measured under the light conditions of with and without asymmetrical glare by using red, green, and yellow filters and ETDRS chart and E-chart.
Results: In both light conditions of with and without glare, the mean visual acuity of the three filters in the right and left eyes was significantly better with the E-chart versus the ETDRS chart ($P < 0.0001$). Only in the glare light condition, the mean visual acuity of the left eye showed no significant difference between the two charts using the red filter ($P = 0.30$).
Conclusions: Visual acuity measurements were different with ETDRS chart and E-chart. These two charts cannot be used interchangeably.

Keywords: Visual acuity charts; Refractive surgery; Colored filters; Glare

Introduction

Visual acuity is the highest performance of the visual system and a conventional clinical index that depends on factors like luminance, contrast, spectral distribution, age, and visual adaptation. In other words, visual acuity depends on the optical and neural functions of the eye,[1] and its simple measurement can reveal many visual disorders. On the other hand, despite new techniques and better equipment, many patients still have visual complaints after refractive surgery. Many studies have evaluated the visual function following refractive surgery and compared different surgical methods.[2–5]

The measurement of visual acuity with different charts is one of the most common ways of the assessment of the visual function to identify visual system abnormalities like refractive errors, disorders of the ocular media, and optic nerve and visual pathway disorders. In general, the principles employed in designing the charts are based on common optical and

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* Corresponding author. Noor Research Center for Ophthalmic Epidemiology, Noor Eye Hospital, Tehran, Iran.
E-mail address: jafarzadehpour.e@iums.ac.ir (E. Jafarzadehpour).
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physiological parameters, and the only difference in charts is related to their design type and measurement accuracy.[6]

The E-chart and ETDRS (Early Treatment Diabetic Retinopathy Study) chart are two charts that are designed based on similar principles and a five-by-five grid pattern. The E-chart (with a design similar to the Snellen chart) is the most common chart in the world that has a big letter on top, and the number of letters increases from the top to the bottom of the chart.[6] This chart is commonly used for the screening of visual acuity in children and assessment of visual acuity in illiterate or non-English speaking patients.[7]

One of the specifications of the E-chart is the evaluation of resolution acuity (the minimum distance between two adjacent points or lines to be recognized as two separate objects)[8]; however, this chart may have some limitations:

1. Due to the varying number of letters in the upper lines of the chart, the value of each letter in the upper lines is not similar to its value in the lower lines.[6]
2. Since the size of the letters in each line does not follow a certain order, it may lead to over estimation in the lower lines.[6]
3. There is much contour interaction in the E-chart.[7,9]
4. The test-retest variability of the E-chart is high thereby decreasing the possibility of the accurate diagnosis of visual changes, which is important for research purposes.[10,11]

However, other standard charts have been designed since 1993. The logarithmic ETDRS is one of these charts. This chart, with Sloan letter optotypes, is a conventional chart for research purposes worldwide which is used as a reference for comparison with other substitute charts.[12]

The ETDRS chart evaluates the recognition acuity of the individuals[13] and has the following advantages:

1. Since the number of letters in each line is similar, each letter has the same quantitative value equal to 0.02 LogMAR (Logarithm of the Minimum Angle of Resolution).[12]
2. The distance between the letters are constant and equal to the size of the letters (about 0.1 LogMAR: Logarithm of the Minimum Angle of Resolution), which controls the crowding phenomenon.[12]
3. As for identification of the letters, the letters used in the chart are in an equal level.[12]

The accurate measurement of visual acuity is very important due to the increase in the prevalence of refractive surgery and dissatisfaction of some patients with their post operative visual acuity. In general, it is not very easy to assess the visual function and detect and measure subjective symptoms of the patients, especially glare symptoms post operatively.[14,15]

Despite the wide use of the ETDRS chart in clinical assessments of visual acuity and research projects worldwide, the E-chart is still used in a decimal (10/10), foot (20/20), or meter (6/6) scale. Since these two charts have different appearances and their results of visual acuity measurement is different according to some studies,[10,16–19] and because there is no clinical standard chart to measure the patients' post operative visual acuity,[5] the question is: can the differences in the design of these two charts result in different visual acuity measurements after optical interventions on the cornea? Therefore, in this study, we used the E-chart and ETDRS chart with three color filters to measure and compare the participants' visual acuity.

Methods

In this cross-sectional study, the patients were selected from the individuals who visited Noor Eye Hospital in Iran for periodic examinations 3–11 months after PRK (Photorefractive Keratectomy) surgery for myopia or myopic astigmatism refractive error.

Exclusion criteria were any corneal pathology, glaucoma, residual refractive errors more than ±0.5 Diopter (D) of myopia or hyperopia, residual astigmatism more than −0.75 D of with-the-rule astigmatism and more than −0.25 D of against-the-rule and oblique astigmatism, and poor understanding of English letters.

All the participants were examined in the same room. To be sure, the English letters were mentioned to all patients before starting the test. Since the E-chart was used to measure the visual acuity of the patients before surgery, both the E-chart and the ETDRS chart (Nidek Chart Projector, CP-770/ Ophthalmic Instrument Company, Porana Business Park Unit 12/77 Porana Road, Glenfield, Auckland, New Zealand) were used at a standard distance (6 m) and in standard light conditions (BS4274) (measured by Photometer, model 606 027, Leybold Company, LD DIDACTIC GmbH Leyboldstr (Fig. 1). 1 D-50354 Hürth, Germany) to evaluate their post operative visual acuity. In all patients, the trial frame was placed in front of the eyes, and one eye was occluded at the time of examination. Uncorrected visual acuity was measured first in the right eye with two charts and then in the left eye. Both charts were randomly selected for each eye. The line assignment method was used[3]; the whole chart was lit, and the test continued until the patient was unable to answer more than half of the letters in a line.

Visual acuity measurements were first performed in normal light conditions without the color filters. Then, to create an asymmetrical light condition (which is more similar to natural conditions), the visual acuity was again evaluated after a halogen light source was placed on the left side of the patient (about 40 cm from the left and 46 cm from the right eye) that created a light intensity of 95 Lux in the left eye and 35 Lux in the right eye. After that, the same light conditions were used for the measurement of visual acuity using yellow (Band Pass Filters), green (High Pass Filters), and red (Low Pass Filters) filters. The yellow filter used in our study was in range of 0.433 x and 0.476 y in the International Commission on Illumination (CIE) diagram measured with a spectrophotometer (Cecil-Reflectascan-ce-3055). It should be mentioned that the optical density of the three filters was similar. The filters were randomly used. To prevent adaptation to color filters, all

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