Relationship between Visual Acuity and Contrast Sensitivity Testing in Low Vision Patients of Different Age Groups

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

Original Research Article

ABSTRACT

Objective: To find a relationship between visual acuity and contrast sensitivity testing in low vision patients of different age groups. Effect of visual acuity and contrast sensitivity on increasing age of low vision patients.
Study Design: Descriptive cross-sectional study.
Materials and Methods: The study included low vision patients of different age groups. Data was collected by Performa. Visual acuity was assessed by ETDRS chart and contrast sensitivity was checked by the peli-Robson chart at different distances. Data were analyzed by using SPSS 22.00.
Results: The study included a total of 64 patients with low vision of different age groups. Out of 64 patients, 31(48.44%) were males and 33(51.56%) were females. Patients with age group 1-15(15.63%). Patients with age group16-30(50%) and patients with age group above 30(34.36%). Relation between CS and VA of RE with age groups. In the age group 1-15, 2 patients have VA 0.9 and CS 0.10, in age group 16-30, 4 patients have VA 0.9 and CS 0.30 and in the age group of above 30 years 2 patients have VA 1 and CS 0.30. The relation between CS and VA of LE in different age groups of low vision patients in age group 1-15, 2 patients have VA 0.7 and CS 1.35 similarly in age group 16-30, 4 patients have VA 0.9 and CS 0.30 and in the age group above 30 years 2 patients have VA 1.3 and CS 0.75.

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Conclusion: It is concluded that the statistical value is significant P_ 0.00 which shows a significant result. And it shows that there is a strong relationship between visual acuity and contrast sensitivity as age increases visual acuity and contrast decreases so age has to affect visual functions.

Keywords: Low vision; ETDRS chart testing; visual acuity; and contrast sensitivity relation; peli-robson chart testing.

1. INTRODUCTION

According to WHO, a person having visual function impairment even after the best-corrected vision, has visual acuity < 6/18 and visual field < 10 degree from target, but is potentially able to use vision for work due to low vision aids to improve his quality of life [1]. People with low vision having difficulties to perform their daily life activities. As they have worse visual acuity binocularly so these people cannot be treated pharmacologically or medically and also we cannot do surgery of these people. For this purpose we require special care so, many low vision rehabilitation services are available to treat these people by providing low vision aids. There are some major causes of low vision glaucoma, cataract, corneal opacity, macular degeneration, diabetic retinopathy, etc. [2] Visual acuity is defined as how clearly a person can see an object. But in low vision patients, visual acuity assessment depends upon the design of bailey_lovie letter chart which explains the principles of this design and development of log MAR units. It also explains how the progression of sizes of optotype occur and proper letter to letter scoring is important for assessment of visual acuity in low vision clinical work. So it is decided to measure visual acuity in terms of logarithms of the minimum angle of resolution as log MAR unit [3]. A standard method to measure visual acuity in low vision patients is ETDRS chart having log MAR unit. This chart consists of 5 characters in each row which is in the regular and proper pattern. Distance visual acuity is measured at 4m distance. Visual acuity is measured in log MAR unit. So values gradually decrease from top to bottom. Near visual acuity charts are available for low vision patients. Tumbling E chart and cut-off **C** chart are also available for testing visual acuity in low vision·[4]. Contrast sensitivity is defined as the ability to differentiate objects from the background. The contrast sensitivity function is defined as the low intensity of the background or when the background is dim. A standard method to measure contrast sensitivity is Peli –Robson chart. This test is performed at 1m. Contrast is gradually decreased from top to bottom but contrast sensitivity gradually increases from top to bottom. The prevalence of low vision in Pakistan is 1.7%. An estimated 727,000 adults in Pakistan have low vision and need low vision rehabilitation services [5]. Prevalence of low vision in India was 4.2% of persons with ARMD were blind which the leading cause of low vision is. In this study, visual acuity by ETDRS chart and contrast sensitivity by Peli –Robson chart would be checked in low vision patients of different age groups having different diseases [6]. A study shows contrast sensitivity and visual acuity checked in 20 low vision patients. Out of 20(12 males & 8 females) and 5 normal vision patients (2 males &3 females) of different age groups. They observed normal vision patients have good visual acuity binocularly but low vision patients have worse visual acuity and also have different diseases. So they concluded that these diseases lead to a reduction in visual acuity and contrast sensitivity so these are the main causes of low vision [7]. Another study showed that contrast sensitivity was checked in healthy young adults having the best visual acuity on the ETDRS chart by two different methods. They observed 180 adults by using OPTEC 6500 (FACT) in photopic and mesopic and CSV-1000E in photopic light. They calculated the index of contrast sensitivity between both test methods. They showed contrast sensitivity and index contrast sensitivity values in adults having normal visual acuity they showed little agreement between both tests [8]. The study aimed to compare the measurement of visual acuity by two different methods. Computerized visual acuity measurement and gold standard ETDRS chart in the patients of ARMD and DR. 50 patients of AMD (mean age 85 years) were taken visual acuity measured by COMPlog C5 AND C3 algorithm and gold standard ETDRS chart. C5 AND C3 showed no bias comparison from ETDRS chart visual acuity measurement so COMPlog had equal TVR to ETDRS chart [9]. Recently another study was conducted on contrast sensitivity. This told about the new methods for measuring contrast sensitivity. They estimated contrast sensitivity in 25 trials by

different methods. They concluded that there are different methods available to measure contrast sensitivity like forced choice, scale, many alternatives but the best one is the peli-Robson chart for the rapid and correct measurement of contrast sensitivity in low vision [10]. The study evaluated the long-term visual acuity outcomes assessment by crowded HOTV and ETDRS chart. A total of 40 children were diagnosed with small cataracts. Out of 40 children, 24 (60%) had abnormal visual acuity and 9(23%) had severe visual acuity loss (20 /80) in both eyes. Abnormal visual acuity and contrast sensitivity during the assessment were the predictions of long–term visual acuity outcomes. So it was concluded that visual acuity and contrast sensitivity assessment showed visual impairment of the visual system [11].

The study was conducted on 46 healthy medical interns in whom 21 males and 25 females were included. Distance visual acuity was tested by using iPad 3 devices and standard ETDRS chart. It was concluded that iPad 3 device could be used as an alternative to ETDRS chart for measuring distance visual acuity in low vision patients [12]. This study explains the different components of vision which may affect the ability of glaucoma patients to function properly which is the main cause of low vision. Total 192 glaucoma patients were selected. Visual acuity, contrast sensitivity, visual field and stereopsis were checked in those patients. It was concluded that binocular visual acuity and contrast sensitivity best predict the ability of a patient with low vision and glaucoma to perform their daily life activities [13]. The study showed the development of visual acuity and contrast sensitivity in children. It was concluded that visual acuity fully developed in childhood but contrast sensitivity fully developed in teenagers [14]. Another study revealed that visual acuity and contrast sensitivity were checked in athletes. Visual acuity was checked by bailey-Lovie chart and ETDRS chart and contrast sensitivity was checked by the peli-robson chart. It was concluded that the most important factors for athletes are visual acuity and contrast sensitivity to perform their activities [15].

2. MATERIALS AND METHODS

It was an institutional-based study conducted on 64 patients having age1-15 years, 15-30 years, 30…. years of patients were included. Patients with irreversible visual loss were included in this study. This study explained the relationship between visual acuity and contrast sensitivity testing in low vision patients of different age groups. Patients who don't want to get permission to perform these tests willingly were excluded from this study. Data was collected by a self-designed proforma. All the data was entered and analyzed using Statistical Software SPSS Version 22.00.
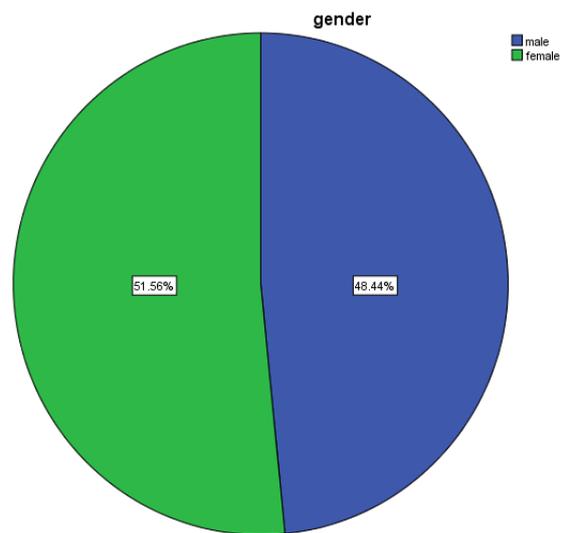
3. RESULTS

Fig. 1. Distribution of age

Figure shows total 64 patients were included. Out of 64, 31(**48.44%)** were males and 33**(51.56%)** were females.

Figure shows patients of different age groups. Patients with age group 1-15**(15.63%).** Patients with age group16-30**(50%)** and patients with age group above 30**(34.36%).**

Bar chart shows best-corrected visual acuity of the right eye in different groups of low vision patients. Total 10 patients were included in age group 1-15; in this group 3 patients have VA 0.8**(3.13%),** 32 patients were included in age group16-30; in this group, 9 patients have VA0.9**(14.06%)** and 22 patients were included in the age group of above 30, in this group 6 patients have VA 1(**9.38%).**

Bar chart shows best-corrected visual acuity of left eye in different age groups of low vision patients. In age group of 1-15, 3 patients have VA 0.7**(3.13%),** in age group of 16-30 total 9 patients have VA 0.9**(14.06**) and in age group of above 30 years 6 patients have VA 1**(9.385**).
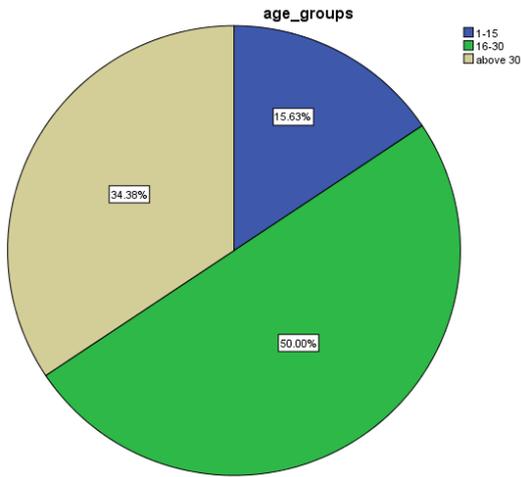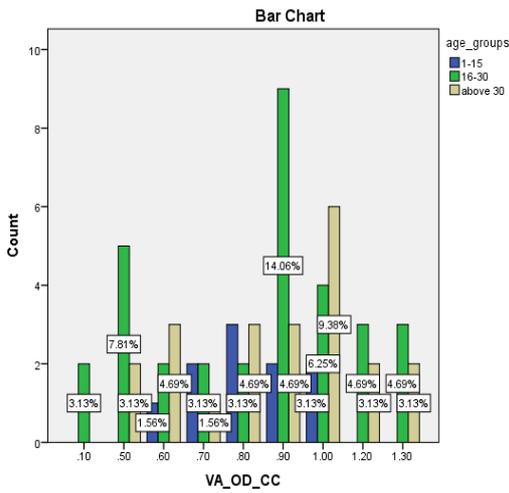
Fig. 2. Distribution of gender

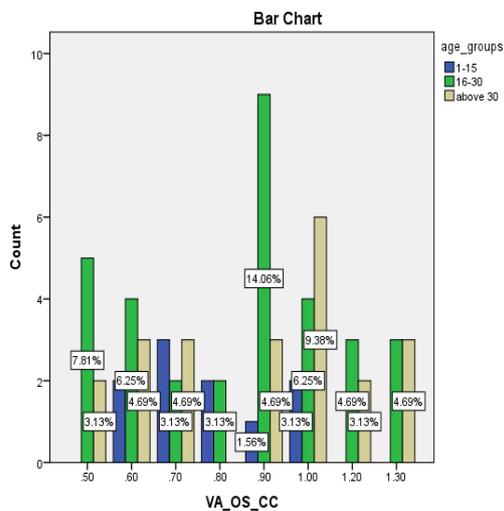**Fig. 3. VA_OD_CC * age groups**

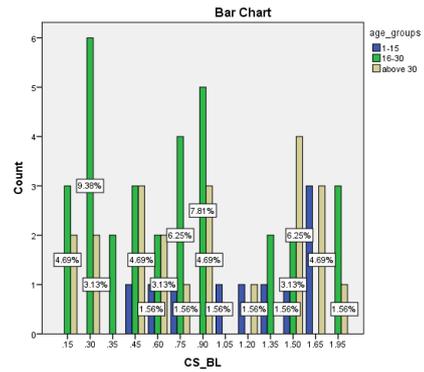**Fig. 4. VA_OS_CC * age groups**

Fig. 5. CS_BL * age groups

Bar shows the contrast sensitivity values for different age groups in low vision patients. In group 1-15; 3 patients have CS value1.65**(4.69%),** in group 16-30; 6 patients have CS value0.30 **(9.38%)** and in group above 30 years 4 patients have CS value 1.50**(6.25%).**
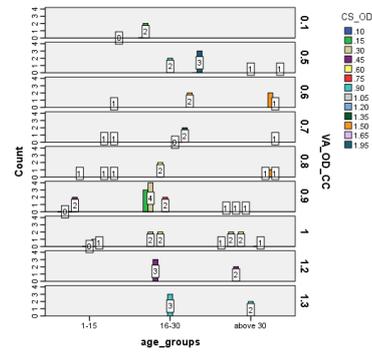

Fig. 6.

Graph shows the relation between CS and VA of RE with age groups. In age group **1-15**, 2 patients have VA 0.9 and CS 0.10, in age group **16-30**, 4 patients has VA 0.9 and CS 0.30 and in age group of above 30 years 2 patients have VA 1 and CS 0.30.
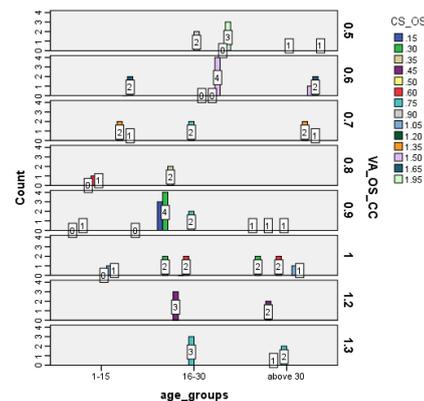

Fig. 7.

Graph shows the relation between CS and VA of LE in different age groups of low vision patients in age group **1-15,** 2 patients have VA 0.7 and CS 1.35 similarly in age group **16-30**, 4 patients have VA 0.9 and CS 0.30 and in age group above 30 years, 2 patients have VA 1.3 and CS 0.75.

Friedmen test for left eye:

Table 1. Ranks

	Mean Rank
age	3.00
VA_OS_CC	1.56
CS_OS	1.44

Table 2. Test Statistics[a]

N	64
Chi-Square	96.500
df	2
Asymp. Sig.	.000

a. Friedman Test

Friedmen test shows the significant result. It is statistically concluded that p value for left eye 0.00 and there is a strong relationship between visual acuity and contrast sensitivity in low vision patients.

Friedmen test for right eye:

Table 3. Ranks

	Mean Rank
age	3.00
VA_OD_CC	1.56
CS_OD	1.44

Table 4. Test Statistics

N	64
Chi-Square	96.500
df	2
Asymp. Sig.	.000

a. Friedman Test

Friedmen test shows a significant result. it is statistically concluded that there is a relation between visual acuity and contrast sensitivity in low vision patients and age has a significant effect on visual functions in the right eye of patients.

4. DISCUSSION

An efficient method of determining a full CSF is useful for individuals with normal vision, but it is especially useful for low vision as the peak contrast sensitivity is a good predictor of daily activities such as mobility, face recognition, and reading. In the laboratory, full low-vision CSFs can be used as filters to recreate visual stimuli that simulate what individuals with low vision can detect. This may be a useful tool for informal evaluation of the impact of vision impairment, especially acuity loss and reduced contrast sensitivity, on the visibility of real-world objects and scenes [7]. So a detailed study was carried out to find out the major eye diseases leading to low vision and blindness in southeast Nigeria. The purpose of the study was to find which visual components mostly affect the functions of glaucoma patients which could cause low vision. Quality of life could be affected by eye diseases as a patient could not be able to perform their routine life work due to reduced visual acuity and loss of visual field. The relationship between different visual functions was assessed to check which component mostly affects the quality of life. It was observed that a patient with loss of visual field is more affected to perform his daily life activities as compared to a patient having reduced visual acuity but in the case of low vision patients, visual acuity is the most important factor, as well as other visual functions, may also affect. So it was concluded that there is a strong relationship between all vision components to maintain the activities of life, especially in low vision patients [16]. As fall is the risk factor so it was reported that severe visual loss is strongly related to hip fracture [17]. Another study explain different visual functions in low vision patients and their relation with quality of vision and quality of life because low vision patients cannot comfortably perform their daily life activities as a normal person can do. So a strong relationship was found between visual functions in low vision patients [18]. In this study the need for services was categorized into four components based purely on distance visual acuity. In reality, the delivery of low-vision services should be needs-based, multidisciplinary, and flexible, focusing on improving functional abilities. For example, an individual whose employment depends on reading small print has different requirements than does someone who is illiterate but who wants to continue farming or attending social functions. The optimal low-vision team comprises eye care personnel, occupational therapists, adaptive technology specialists, teachers, audiologists, and members of the social services and state blind societies. The mutual goal of these groups is to provide appropriate equipment together with specific orientation and training to

allow the individual to maintain independence. In general, optical devices (including distance or near magnifiers, field expanders, night-vision aids) are less useful for those with poorer levels of visual function, and those affected require environmental modification (e.g., light augmentation, improving mobility). Individuals with very poor or no visual function will require rehabilitation including sensory substitution (accessing information via tactile or auditory methods) [5].

5. CONCLUSION

> It is concluded that the p-value is 0.00 which is significant and shows a correlation between visual acuity and contrast sensitivity in low vision patients of different age groups as age is an important factor that affects visual functions.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rakhi DLD. Revision of visual impairment definitions in the International Statistical Classification of Diseases. BMC Medicine. 2006;4(1).
2. Azuamah Y, Amadi A, Esenwah E, Iloh G. Major causes of low vision and blindness in southeast Nigeria. International Journal of Health Sciences and Research (IJHSR). 2013;3(12):48-52.
3. Bailey IL, Lovie-Kitchin JE. Visual acuity testing. From the laboratory to the clinic. Vision research. 2013;90:2-9.
4. Shamir RR, Friedman YG, Joskowicz L, Mimouni M, Blumenthal EZ. The influence of varying the number of characters per row on the accuracy and reproducibility of the ETDRS visual acuity chart. Graefe's Archive for Clinical and Experimental Ophthalmology. 2016:1-6.
5. Shah SP, Minto H, Jadoon MZ, Bourne RR, Dineen B, Gilbert CE, et al. Prevalence and causes of functional low vision and implications for services: The Pakistan National Blindness and Visual Impairment Survey. Investigative ophthalmology & visual science. 2008;49(3):887-93.
6. Kulkarni SR, Aghashe SR, Khandekar RB, Deshpande MD. Prevalence and determinants of age-related macular degeneration in the 50 years and older population: A hospital based study in Maharashtra, India. Indian journal of ophthalmology. 2013;61(5):196.
7. Chung ST, Legge GE. Comparing the shape of contrast sensitivity functions for normal and low vision comparing CSF for normal and low vision. Investigative ophthalmology & visual science. 2016;57(1):198-207.
8. Koefoed VF, Baste V, Roumes C, Høvding G. Contrast sensitivity measured by two different test methods in healthy, young adults with normal visual acuity. Acta ophthalmologica. 2015;93(2):154-61.
9. Bokinni Y, Shah N, Maguire O, Laidlaw D. Performance of a computerised visual acuity measurement device in subjects with age-related macular degeneration: Comparison with gold standard ETDRS chart measurements. Eye. 2015;29(8):1085-91.
10. Pelli DG, Bex P. Measuring contrast sensitivity. Vision research. 2013;90:10-4.
11. Birch EE, Subramanian V, Patel CC, Stager D. Preoperative visual acuity and contrast sensitivity in children with small, partial, or non-central cataracts. Journal of American Association for Pediatric Ophthalmology and Strabismus. 2013;17(4):357-62.
12. Manzano AA, Lagamayo MAN. A comparison of distance visual acuity testing using a standard ETDRS chart and a tablet device. Philipp J Ophthalmol. 2015;40:88-92.
13. Richman J, Lorenzana LL, Lankaranian D, Dugar J, Mayer J, Wizov SS, et al. Importance of visual acuity and contrast sensitivity in patients with glaucoma. Archives of ophthalmology. 2010;128(12): 1576-82.
14. Leat SJ, Yadav NK, Irving EL. Development of visual acuity and contrast

sensitivity in children. Journal of Optometry. 2009;2(1):19-26.

15. Zimmerman AB, Lust KL, Bullimore MA. Visual acuity and contrast sensitivity testing for sports vision. Eye & Contact Lens. 2011;37(3):153-9.

16. Lamoureux E, Gadgil S, Pesudovs K, Keeffe J, Fenwick E, Dirani M, et al. The relationship between visual function, duration and main causes of vision loss and falls in older people with low vision. Graefe's archive for clinical and experimental ophthalmology. 2010;248(4): 527-33.

17. Ivers RQ, Optom B, Cumming RG, Mitchell P, Simpson JM, Peduto AJ. Visual risk factors for hip fracture in older people. Journal of the American Geriatrics Society. 2003;51(3):356-63.

18. Gil MA, Varon C, Rosello N, Cardona G, Buil JA. Visual acuity, contrast sensitivity, subjective quality of vision, and quality of life with 4 different multifocal IOLs. European journal of ophthalmology. 2011;22(2):175-87.

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