Cataract evaluation by differential contrast sensitivity

Alexandros Pennos*, Lucia Herveta, Eloy Villegas, Juan Tabernero and Pablo Artal

Laboratorio de Optica, Universidad de Murcia, Murcia, Spain

*Corresponding: pennos@um.es

The impact of glare is evaluated in a group of cataract patients and compared with a control group consisted of normal subjects. Contrast sensitivity functions (CSFs) with and without glare were measured. A Hartmann-Shack sensor was used to quantify the amount of cataract in each eye. The glare source had a negative impact on the CSF in subjects with cataracts, but there was not a significant impact in the control group. Differential CSFs may provide an additional approach to quantify the degree of cataracts.

Keywords: cataract eyes; glare; CSF

1. Introduction

Visual acuity is not a good descriptor of the degradation of vision due to the presence of elevated intraocular scattering due to early stages of cataract. The contrast sensitivity function (CSF) provides a more complete description on the vision although may still have some drawbacks for cataract evaluation. First the impact of moderate scattering would be still limited and typically methods to measure are usually tedious. This last issue is partially solved by using a precise, repetitive and easy to set-up method to measure CSF, called quick CSF (qCSF) [1]. This method uses a Bayesian adaptive procedure that reduce the time required to measure the CSF. The relative insensitivity of the CSF to scatter is addressed by measuring in the same subject and with the same instrument two CSFs, with and without the presence of glare.

2. Materials and Methods

Subjects

Nine subjects (aged between 70-80 years) with various types of cataract were selected from pre-operative, cataract surgery, examinations. Another fourteen subjects (range age) with no evidence of crystalline lens opacity or any other ocular disease, were used as control group. All subjects underwent an evaluation through a series of measurements including images from a slit lamp along with objective, qualitative and quantitative analysis of Hartmann-Shack images using a procedure previously applied with double-pass images [2]. Visual acuity tests were also performed using Snellen chart. Figure 1 shows an example of the optical measurements.

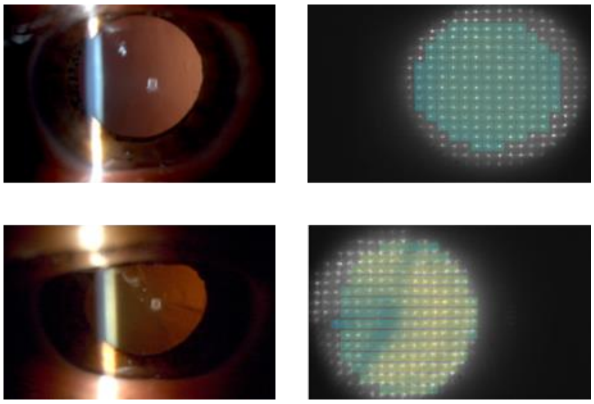

Figure 1. Optical measurements (slit-lamp and HS scatter maps). Upper images: Normal subject. Lower Images: Cataract subject.

The qCSF with glare method.

All qCSF tests were performed on a personal desktop computer using a standard PC screen (Philips 191V2). The test area had a diameter of 11.1 centimeters, centered and enclosed on an orthogonal background of 41 by 23.1 centimeters. The background was either black, or white, representing the two different modes of the test, without or with, respectively, the presence of glare. The screen was placed at a distance of 100 centimeters away from the subject, resulting the test area to lay on 6.36 degrees of visual field. The glare source was covering a field from 3.18 up to 6.59 degrees on both sides horizontally up to 6.56 vertically. The luminance of the glare area was 150 cd/m^2. In the control group, for each testing condition 2 measurements of 100 trials each, monocular for the dominant eye, were taken. For the cataract group, measurements were monocular as well but for both eyes. In order to maintain a tolerant level of comfort, all tests on this group were only done once. Spatial frequencies between 2 and 20 cycles per degree were projected, estimating the sensitivity for each one. Figure 2 shows the two testing conditions.

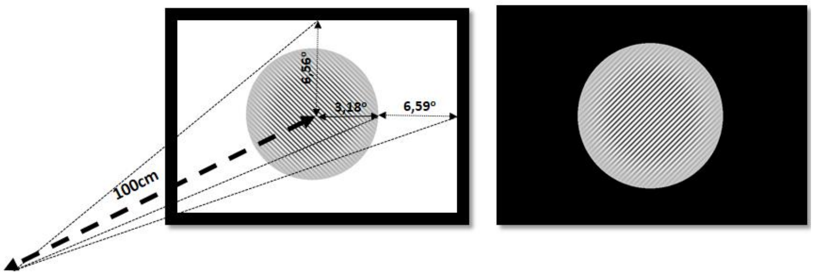

Figure 2. A schematic of the test screen. Left: A representation of the setup with glare. Right: Without glare

3. Results

Figure 3 shows the average sensitivity with and without glare in two ranges of spatial frequencies, low to medium (2 to 6 cycles per degree) and medium to high (7 to 20 cycles per degree). Figure 4 shows the average difference in sensitivity for the two groups. Especially in the range of low spatial frequencies, sensitivity with glare decreased in the cataract group. However, in the case of the normal reference group the glare source actually improved sensitivity. The reason for this would be the possible reduction in pupil diameter together with the small impact of the glare in those eyes. A comparison in each eye of the measured optical parameters and the differential sensitivity was also performed.

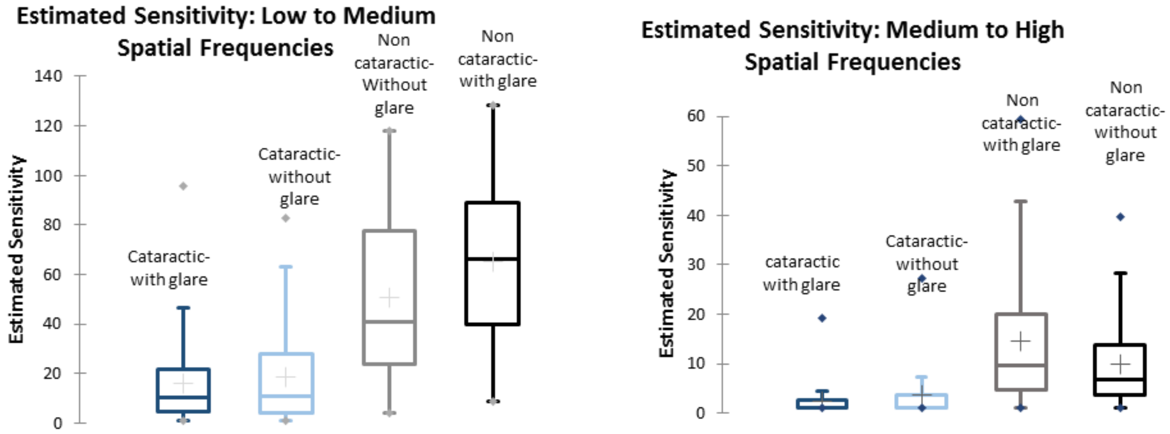

Figure 3: Comparison of sensitivity between the normal and cataract groups for the two ranges of spatial frequencies

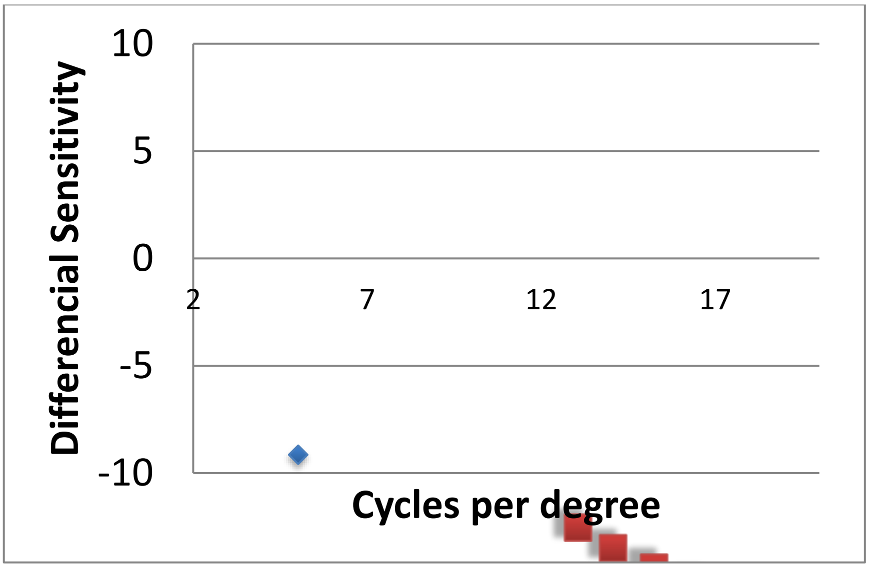

Figure 4. Difference of sensitivity between no-glare and glare conditions for normal (blue symbols) and cataract subjects (red symbols).

3. Conclusions

The comparison of contrast sensitivity with and without glare provides a visual method to evaluate cataract that is complementary to different optical methods. For patients quick screening, a further simplified version of this approach could be implemented.

References

1. Lesmes L, Lu Z, Baek J, Albright T. Bayesian adaptive estimation of the contrast sensitivity function: the quick CSF method. J Vis. 2010;10:1–21. doi:10.1167/10.3.17.

2. Artal P, Benito A, Pérez GM, et al. An objective scatter index based on double-pass retinal images of a point source to classify cataracts. PLoS One. 2011;6(2):e16823. doi:10.1371/journal.pone.0016823

This work was supported by EU-ITN OpAL (PITN-GA-2010-264605) and by an European Research Council Advanced Grant ERC-2013-AdG-339228 (SEECAT) to P. Artal.