Optometry 699 - Special Studies

DO CORNING FILTERS IMPROVE VISUAL FUNCTION?

by

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ABSTRACT: Nuclear sclerotic cataracts are one of the most common causes of decreased vision and increased sensitivity to light. This type of lens opacity occurs in "60 - 65% of the population age 50 - 59 years, 83% in the age group 60 - 69 years, 91% in the 70 - 79 year age group and 100% in the age group over 80 years." [1] Glare from sunlight, reflections and headlights is the most bothersome and disabling sequela of nuclear sclerotic cataracts. Color vision, stereo acuity, visual acuity and light adaptation time may also be affected with such lenticular changes. [1] But it is glare complaints or decreased vision that brings the patient into the optometrist's office. The patient's subjective visual complaints have recently become a legitimate indication for cataract extraction.[2] "Contrast sensitivity and glare disability measurements have been proposed as supplying supporting psychophysical evidence for the need for surgery in cataract patients who retain relatively good V.A." [2] Cataract surgery is now considered a safe, successful and fairly simple procedure. However, not all patients are good candidates for the surgery. There are physical, emotional, and financial barriers that must be considered.[1] For those patients who are not able or willing to undergo cataract surgery, Corning has developed a filter to improve their quality of vision.[3] The aim of this study is to prove the vision-enhancing effects of this filter.

INTRODUCTION:

The formation of nuclear sclerotic cataracts can be considered an "exaggeration of the normal aging change involving the lens nucleus." [4,5,6,7] Throughout life, the crystalline lens continuously produces cells or fibers made of protein. The oldest fibers are pushed centrally to become more condense and inert. [6]

The unique and uniform pattern of the tightly packed fibers allows the lens to be transparent.[8] The clarity of the lens is put in jeopardy with the exposure of the protein fibers to oxygen, ultraviolet light, and the products of normal aging.[9] Other risk factors include pathology (ocular and systemic), heredity, trauma and adverse environmental conditions.[6] The decrease in transparency is due to the changes in the chemical nature of the lens fibers. These chemical alterations include replacement of soluble proteins with insoluble proteins, loss of water, oxidation of sulfhydral groups, production of non-disulfide covalent cross-links between crystalline polypeptides and an increase of urochrome deposition in the lens nucleus.[5,6,7,10] This accumulation of urochrome is the reason for a gradual change of the lens nucleus from clear to yellow to brown to black.[7] The chemical changes of the lens fibers are compounded by a number of age-related physiological changes, including reduction in fiber permeability, oxidative activity and metabolism.[6,10]

Often the earliest detectable change with nuclear sclerosis is decreased hyperopia or increased myopia due to a higher index of refraction of the lens.[5] Chemical and physiological variations are responsible for an increased lens density which alters the normal passage of light to the retina. The longer wavelengths of light are allowed to pass through the lens while the shorter wavelengths are dispersed.[6,11,12] The scattering of light caused by nuclear sclerotic lenticular changes precipitates distortion and decreased visual function also known as glare.

"Glare is any source within a visual field creating a variety of effects including veiling retinal illumination."[13]

Glare can be divided into two different categories, spot glare and veiling glare. Spot glare is described as light coming from a single concentrated light source within the field of vision.[14] On the other hand, veiling glare covers an extended area in the field of vision.[14] Nuclear sclerotic cataracts produce a veiling glare with much the same effect as looking through a dirty windshield while driving into the sun, diminishing the contrast of objects within the entire field of view.[14] Blue light, the dominant component of glare, enters the cataractous eye becoming highly scattered.[11,15] The result is glare disability and reduction in contrast sensitivity which ultimately leads to poorer quality of vision.[14]

It has become a well known and generally accepted fact that visual acuity, as tested by an indoor Snellen acuity chart, is not an accurate or inclusive measure of cataractous disability.[15,16,17,18,19] Even with good Snellen acuity, many patients complain of reduced vision when exposed to glare sources.[2] This can be associated with loss of contrast in the low spatial frequency range.[12] Snellen acuity only detects high spatial frequency loss. "Low contrast letters provide more information than conventional high contrast letter acuity by providing a more sensitive assessment of subtle changes in vision."[20] Contrast sensitivity alone does not render an exact estimate of useful vision. Testing a patient's acuity in a glare induced environment is "a qualitative method of objectively documenting the debilitating effect of light scatter from media opacity."[17] Therefore, taking into account the benefits of both these types of tests, it follows that by coupling a glare source with a low contrast test chart, the most insightful clinical measure of visual performance may be obtained.

"The real world is not black and white, but consists of a variety of shades of colors and contrasts."[16] Contrast sensitivity is the degree that a person is able to distinguish the subtlest details or the differences in luminance of a scene.[21] The eyes and brain together are able to differentiate small changes in colors, patterns, and hues. Therefore, contrast sensitivity measurements monitor the ability to see fine detail and to detect contrast. In this study the Pelli-Robson chart was used to determine the level of contrast sensitivity. "The Pelli-Robson chart was designed to measure contrast sensitivity at low to intermediate spatial frequencies."[2] "Cataracts predominantly affect high spatial frequency contrast sensitivity. However, there were a number of subjects with relatively good visual acuity but with significantly reduced low or intermediate spatial frequency contrast sensitivity. The level of low or intermediate spatial frequency contrast sensitivity has been shown to be related more closely to subjective visual impairment and the perception of real world targets than visual acuity. It follows that these subjects would be more debilitated than visual acuity suggests, and early referral for surgery would be justified." [2]

The Pelli-Robson chart was chosen for this study because of its accuracy, convenience and simplistic testing procedure. It uses letters which are familiar to most patients and is a force-choice test.[21] Testing with letters is considered faster because patients can identify letters more easily than directions of gratings as is done with the Vistech contrast sensitivity test.[21]

The Pelli-Robson chart consists of eight lines of letters all subtending three degrees at one meter.[2,22,23] For each line there are two groups of letters with three letters to a group.[2,23] All the letters in a group are of the same contrast, and the contrast decreases by a factor of 1/1.41 in each successive group.[2] One step of the chart is 0.15 log units.[2,19,23]

The Mentor Brightness Acuity Tester (B.A.T.) is a hand-held instrument with a 60 millimeter bowl-shaped hemisphere.[16,17] The bowl has a 12 millimeter opening in the center through which the patients view the chart before them.[16,17,24] The instrument produces a broad-field peripheral glare environment in which there may be one of three possible illuminance levels. Because it is a broad field source it more closely simulates daytime glare than single point source glare (i.e. headlights or streetlights).[2] The manufacturer describes the lowest light setting as closely matching ordinary room lighting; the medium setting as noon on a clear day or brightness reflected from the surrounding foliage on a clear day when the overhead illuminance is 10,000 footcandles (100 footlamberts or 300 cd/m^2); and the highest setting as noon sun on a clear day at a white sandy beach where overhead illuminance is again 10,000 footcandles.[16,17,19,24]

METHODS:

The subjects recruited for this study were of two general categories: (1) patients, who on routine slit lamp examination, were found to have some grade of nuclear sclerosis and (2) patients with no lenticular changes. All of those involved had Snellen visual acuity of 20/25 or better and were free of any vision-impairing ocular pathology. Tests were performed only on those with undilated pupils. The total number tested was 32 people or 64 eyes (the results and discussion are based on the number of eyes involved). Thirteen of the subjects were aged 10 through 40 years, twelve were between the ages of 40 and 60 years and seven were over the age of 60. The overall range was 10 to 74 years.

All of the tests in this study were done monocularly. Subjects were encouraged to guess if at all unsure about their accuracy. Numerical results from each step of the study were recorded along with any individual subjective comments. The format below was followed with each patient:

1) Snellen Visual Acuity
2) Pelli-Robson Contrast Sensitivity
3) Pelli-Robson Contrast Sensitivity with a Corning CPF 511 yellow filter in front of the eye tested
4) Pelli-Robson Contrast Sensitivity with the B.A.T. over the tested eye

5) Pelli-Robson Contrast Sensitivity with the B.A.T. and the Corning CPF 511 yellow filter over the tested eye.

Vision was measured on each potential subject with the Snellen acuity chart. This was done to set initial guidelines on the population involved and to give familiar baseline acuities. Subjects were tested at the standard 4 meter distance while wearing their best visual correction.

Contrast sensitivity was the second acuity tested. The Pelli-Robson screen luminance was 85 cd/m^2, which is well within the recommended range of 60 to 120 cd/m^2.[2,23] Again subjects were tested monocularly while wearing their best distance correction in addition to a +0.75 diopter sphere to compensate for the one meter working distance. Starting with the letters of highest contrast, each person was given ample time to adjust to the faint letters and read until two letters in a group were called incorrectly. The group previous to this was the last correct and was recorded as the subject's contrast sensitivity.

Our subjects were tested with the B.A.T. at the medium setting due to documented research that this was the most accurate of the three settings for simulating outdoor glare.[2,16] The B.A.T. was held in front of one eye, the other occluded, in a vertical position to allow a direct, unobstructed view of the low contrast chart. The same corrective lenses from the previous tests were used in combination with this instrument. Each subject was given twenty seconds to adapt to the glare field before being tested.

The final step of the strategy was to couple the Corning CPF 511 yellow filter with the B.A.T. while testing contrast sensitivity to prove the theory of improved visual function with yellow filters. Corning reports that "80% of those patients wearing their filters experience sharper vision with greater detail and better depth perception; 87% report significantly reduced glare and haze; and 94% call the lenses beneficial."[25]

RESULTS:

Upon slit lamp examination, thirteen (100%) of the patients in the 10-40 year age group had no nuclear sclerosis. In the 40-60 year age group, eight (67%) had grade 1 nuclear sclerosis (mild yellowing of the nucleus), and four (33%) had grade 2 nuclear sclerosis (more distinct yellowing of the nucleus). Of those aged 60 years and over, seven (100%) had grade 2 nuclear sclerosis.

The average contrast sensitivity without a filter or a glare source in place was 1.613 log units. This varied by degree of nuclear sclerosis (n.s.) with a similar sensitivity in those with grade 1 n.s., a higher sensitivity in those with grade 0 n.s., and a lower sensitivity in those with grade 2 n.s. The range of contrast sensitivities measured were from 1.20 to 1.95 log units.

The contrast sensitivities stayed virtually the same when the Corning CPF 511 yellow filter was added, although subjectively many people commented on its improvement. Only those with grade 0 n.s. had a significant reduction, averaging at 0.12 log units or almost one contrast group difference on the Pelli-Robson chart. The change for those with grade 1 n.s. was 0.075 log units and for those with grade 2 n.s. was 0.007 log units. With the filter, the measurements ranged from 1.05 to 1.95 log units, and the average was 1.543 log units.

The B.A.T. undoubtedly lowered the contrast sensitivity of all participants to give an average score of 1.221 log units. The group with grade 0 n.s. was affected far less than the other two groups showing an average loss of 0.294 log units. Those with grade 2 n.s. lost sensitivity by 0.525 log units and those with grade 1 n.s. by 0.356 log units. All patients were in agreement on the negative effects of the glare source.

The final test with the filter and the B.A.T. used simultaneously while measuring contrast sensitivity gave averages of 1.413 log units (grade 0 n.s.), 1.247 log units (grade 1 n.s.), 0.893 log units (grade 2 n.s.) and 1.184 log units (overall). Comparing the contrast sensitivity results, 97% of the subjects had worse vision and 3% had unchanged vision with the B.A.T. and filter combination than with the original test free of devices. When the filter was added to the glare source, the contrast sensitivity improved for 23%, worsened for 36% and stayed the same for 41% of the participants. The majority or 80% of those who did better had grade 1 or grade 2 nuclear sclerosis. In the group without nuclear sclerosis, 38% had poorer contrast when the filter was added to the B.A.T. and 50% had no change. Improvement in contrast was experienced for 37.5% of those with grade 1 n.s. and 27% of those with grade 2 n.s. Of the subjects in the grade 2 n.s. group, 32% measured no change and 40% measured worse contrast sensitivity. The remainder of the grade 1 n.s. group included 37.5% without a change and 25% with a lower contrast sensitivity.

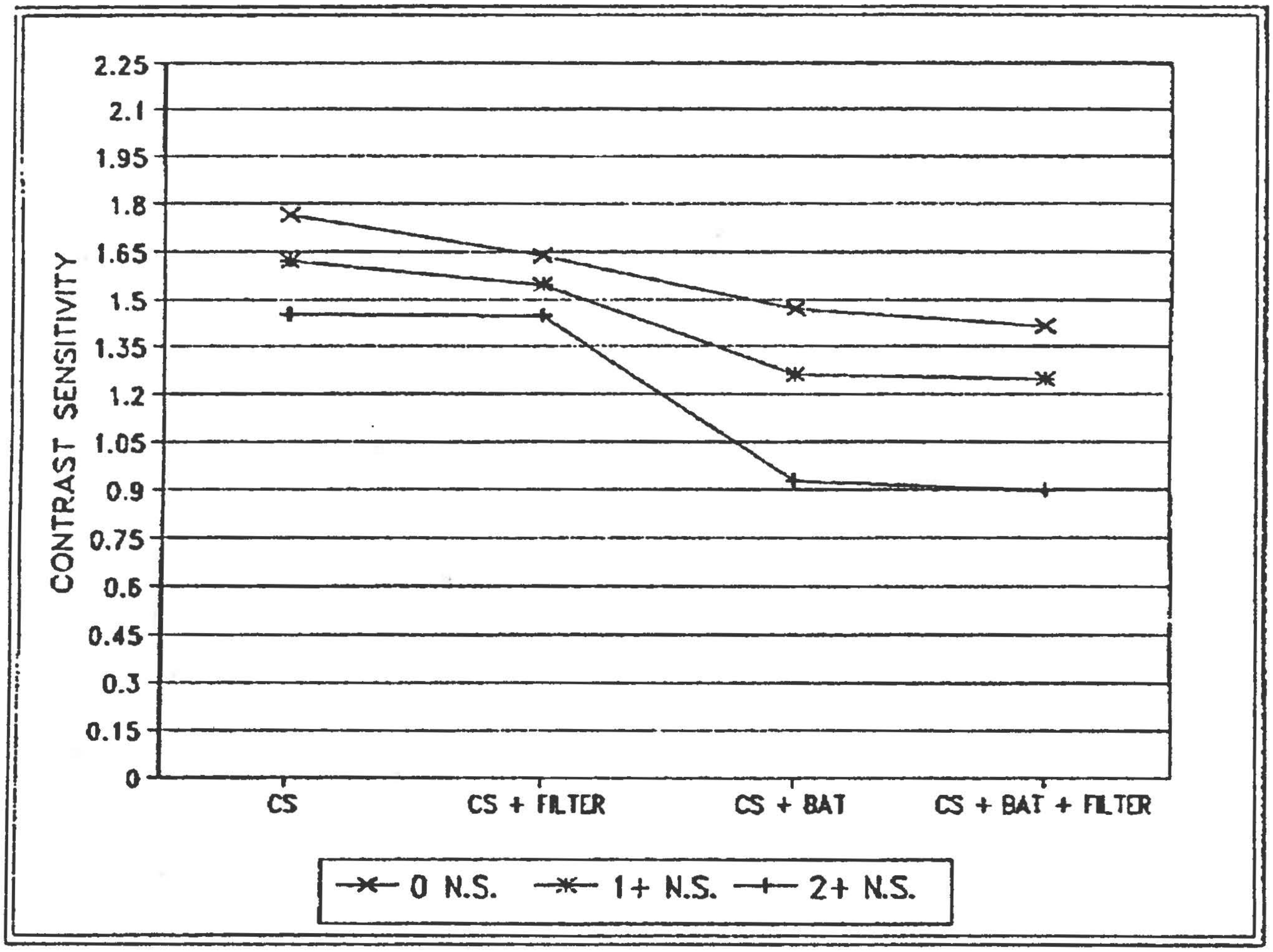
CONCLUSION:

The numerous physical and physiological changes that occur within the lens leading to "optical and histological densification of the nucleus and nuclear cataract" [7] cause unwanted stray and scattered light inside the eye which, in turn, blurs the retinal image and decreases contrast.[14] Under these conditions, one cannot assess quality of vision with Snellen acuity alone. It has been shown that this type of acuity is not an accurate predictor of th ability to cope in real world surroundings of variable contrasts. Reduced visual function can be better estimated by measuring contrast sensitivity under glare duress. This study reconfirmed the dramatic reduction of vision for individuals with nuclear sclerotic cataracts while in the presence of glare.

Corning developed a filter to combat the problem of glare and hazy vision associated with some ocular conditions, especially while outdoors. Results from Corning's study showed "80% experience sharper vision and better depth perception.....87% report significantly reduced glare and haze.....94% call the lenses beneficial."[25] However this study found only 37.5% and 27%, grade 1 n.s. and grade 2 n.s. respectively, with a measurable improvement in contrast and 61% with a subjective improvement of vision. Although some found comfort with the filter, a majority of those tested did not have improved functional vision. Based on the data collected, the Corning CPF 511 filter would not be beneficial to all patients with nuclear sclerotic cataracts with the intent of increasing visual performance, and for some may even decrease their existing functional vision.

It has been proven that intense light with a high ultraviolet radiation component may act as a catalyst in the formation of nuclear sclerotic cataracts.[1,8,9] Protecting the eyes from injurious rays may indeed slow down the process. Although this study did not investigate the use of Corning lenses for this purpose, it is a possibility the filters may provide an actual preventive benefit.

Whether the intent of the Corning filter is for a prophylactic purpose or for the treatment of subjective glare complaints, one should not mislead a patient on the unproven effects of this aid. Each person must be informed when his or her contrast is reduced or even unimproved with the filter, regardless of subjective comfort. We suggest prescribing filters on an individual basis, where the patient subjectively perceives an improvement, and there is no measured loss of vision through the lenses during the proper contrast sensitivity and glare testing.


CONTRAST SENSITIVITY
2.25
2.1
1.95
1.8
1.65
1.5
1.35
1.2
1.05
0.9
0.75
0.6
0.45
0.3
0.15
0
CS
CS + FILTER
CS + BAT
CS + BAT + FILTER
0 N.S.
1+ N.S.
2+ N.S.

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