Impact of cataract on critical flicker fusion frequency: A hospital based study

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Abstract

Purpose: To know whether cataract alters critical flicker fusion frequency.

Design: A hospital based observational study.

Materials and Methods: There were 113 patients with immature cataract fundus view are studied. Pre and post operatively critical flicker fusion frequency (CFFF) test conducted and frequency values noted. All patients were recorded of vision, relative afferent pupillary defect (RAPD), intraocular pressure and dilated fundus findings. Any abnormal fundus, glaucoma and RAPD were excluded.

Results: CFFF values taken for analysis. There was no change in CFFF values post operatively. Those who had higher CFFF values remained higher postoperatively also. And similarly remained low those with lower CFFF values. There was no statistical significance (p-value=0.2182).

Conclusion: Cataract did not alter the CFFF. High or low CFFF values can be concluded as dependant on optic nerve and retinal health status.

Keywords: Cataract, Critical flicker fusion frequency, Fundus.

Introduction

Critical flicker fusion frequency is by definition the frequency of flickering light is perceived as non-flickering and steady. Temporal characteristics can be assessed by flickering light. Area 17 and 18 of cerebral cortex equally involve in distinguishing the flickering.[17] These temporal frequencies evolving patterns are very critical for analysis. This basis of cerebral cortex recognition of critical flicker fusion frequency is strongly supported as there were low critical flicker fusion frequency values found by the brain in Hepatic encephalopathy secondary to cirrhosis of liver.[18] It is still unclear that at what level flickering actually processed even though various studies found as complexity of neuronal responses which tried to quantify. Critical flicker fusion frequency is not depending of retinal location.[19] Better detection of early glaucomatous damage with perimetry based on critical flicker frequency than standard automated perimetry. CFFF depends upon age, wave length of test light, contrast, flicker cycle, dark adaptation, light adaptation, retinal position, luminance and target size.[28] Critical flicker fusion frequency values were low in glaucomatous patients.[20,21] Early detection is of glaucomatous damage is done by critical flicker fusion frequency based perimetry.[22]

By definition cataract is clouding or transparency loss due to protein pump and tissue breakdown. Cataract is debilitating in daily life. Daily tasks are hampered due to low contrast sensitivity, visual acuity, colour perception and stereopsis. Posterior sub capsular cataract affects more than any other cataract among immature type of cataract. Day glare and diminution of vision is more common with posterior sub capsular cataract. Night glare is due to cortical riders and lamellar separation. The reason behind this is the posterior sub capsular cataract proximity at the nodal point. Other type of cataract which affects vision is intumascent cataract, mature cataract, and posterior polar cataract. Treatment of cataract is either by manual small incision sutureless surgery or phacoemulsification technique. For early immature cataracts refraction and spectacle prescription is the first remedy. Spectacles with anti reflective or antiglare coated glasses are prescribed. Computer systems are protected with antiglare coverings.

Critical frequency is at which the eye no more perceives as flickering light when the light emitting diode (LED) bulb is actually flickering. There is more perception of light by the human eye than the static light.[1,8] This is based on temporal perception of light by the brain. Hence it is appropriate to know whether cataract influence the CFFF (Critical Flicker Fusion Frequency) value. The cataract can influence spatial frequency of light.[3,5-7] It is denoted with Snellen chart visual acuity as the nucleus density causes myopic, which is common or hyperopic shift. Presbyopia is the combined result of nuclear sclerosis and decease in ciliary body function with the increasing age.[4] Critical flicker fusion frequency is low with optic nerve diseases.[11,13,15] and fundus degenerations.[13,] Also critical flicker fusion frequency detrimental in glaucomatous patients.[9,16] The present study can be taken up to observe whether cataract influences critical flicker fusion frequency or not.[10,12]

Materials and Methods

This is hospital based observational study.

Individuals who had cataract with normal fundus[14] and were posted for cataract surgery recruited.[1] Male

and females individuals more than 40 years were recruited. Male and females are taken equal in number.

Every patient was examined for visual acuity by Snellen chart, intraocular pressure by Goldmann applanation tonometer after instilling topical proparacaine, fundus examination with pupils dilated with tropicamide with phenyephrine. Fundus examination carried with 90D lens slit-lamp biomicroscopy.[2]

Exclusion Criteria: Patients the pathological myopia, dense cataract without fundal view, Optic nerve diseases such as papillitis, recovered papillitis, early glaucoma, ocular hypertension, primary open angle glaucoma, macular degenerations such as Age related macular degeneration both dry and wet type, chloroquine maculopathy, proliferative diabetic retinopathy, clinically significant macular oedema and central nervous disorders.

Inclusion Criteria: Patients with lenticular opacities ranging from lamellar separation, intumascent cataract, senile nuclear sclerosis upto grade 2, and posterior sub capsular cataract with view to fundus. All the above patients were examined with 90 Diaptor lens slit lamp bio-microscopy. Those were found with normal fundus are recruited.

Critical flicker fusion test is carried with in-house built device.[4] Device has red light emitting diode bulb which flickers. Device is kept 1 meter away from the patient at regular room illumination. We did not make the room dark because of practical implications and simulating exposure routine working environment. Diode bulb had 3mm diameter with red luminance which delivers frequencies from 0 Hz to 50 Hz. To quantify the frequencies we used audio SweepGen 3.7.4.36 software on computer. This software was down loaded from online web network. Computer was kept mute so that noise is reduced and patient can concentrate on the flickering light. All the patients were taken consent verbally as the procedure is safe and non-invasive. Patient is asked to focus on the light continuously. Subject is allowed to blink his or her eye owing to dryness of eyes due to continuous eye opening. From zero frequency of light emitting diode bulb in which blinking of light was obvious, slowly increased 1 step higher frequency until the patient perceives as single light or non-flickering light. Once the patient sees the flickering light as static and further increase in frequencies are done. As the patient is seeing non flickering light slowly frequencies reduced to the steps of 1Hz till the patient sees again the light starting to flicker faintly. This is matched with the frequency at which flickering light appeared during incremental frequencies. If the incremental and detrimental frequencies are coinciding at certain frequency is taken as critical fusion frequency. Frequency at which the flickering light appeared as single light was noted as critical flicker fusion frequency.[5] The same procedure is repeated post operatively on the first post operative day. Recorded of above parameters post operatively also. The time of examination was kept in same scheduled time both pre operatively and posts operatively to avoid bias with the surrounding illumination as critical flicker fusion frequency is altered with back ground luminance, dark adaptation and light adaptation. Patients with increasing age had a long learning curve in performing critical flicker fusion frequency test.

Results

There were 120 patients, who were scheduled for cataract surgery. Out of which 6 patients were cancelled due to high blood pressure and sugars. One patient had cardiac disease and was cancelled of cataract surgery. Total 113 cases were taken for analysis. Pre operative eyes had mean CFFF 32.90 (SD= 2.923) and post operative critical flicker fusion frequency mean of same eyes was 33.40 (SD=3.211). Two tailed p-value of t-test was 0.2182 indicating no significant change in critical flicker fusion frequency post operatively. There were unpaired group as the patents underwent cataract surgery and 7 patients less when compared with the pre operative group.

Unpaired *t* test results:

	Pre op	Post op
Mean	32.90	33.41
SD	2.94	3.23

P value and Statistical Significance:

The two-tailed P value equals 0.2203

By conventional criteria, this difference is considered to be not statistically significant.

Confidence Interval:

The mean of group one minus group two equals -0.50

95% confidence interval of this difference: From -1.31 to 0.30

Intermediate Values used in Calculations:

t = 1.2292

df = 224

standard error of difference = 0.410

Table 1: Pre and post operative CFFF

Test type	No. of Patients	Mean	Std Deviation	t-value	p-value
Pre op	120	32.90	2.923	1.2347	0.2182
Post op	113	33.40	3.211		

The preoperative mean is lower than the western individuals. This discrepancy can be explained as the India has low literacy rate and majority were from rural area that came through community campaigns where the lack of education and health is present. Post operative means of critical flicker fusion frequencies are slightly higher than the pre operative ones. This change however was not clinically significant (p=0.2182). Moreover there were seven subjects who did not undergo cataract surgery. If these would have been added, there may be even lesser difference than we got in our results.

Conclusion

Critical flicker fusion frequency is not altered by the cataract. Hence it can be used to determine the outcome of vision in persons with mature cataract with hazy retinal details. Since the critical flicker fusion frequency is not altered by the lens opacity, it can be used to assess the post operative visual outcome.[31-33] Low critical flicker fusion frequency values indicates the retinal status and the optic nerve status like macula degeneration, papillitis[29] because of involvement of magnocellular axonal projection are involved or optic atrophy.[25] Higher critical flicker fusion frequency value better the visual acuity. It is confirming that flicker frequency is temporal and connected to neuronal integrity.

Discussion

Flickering lights will be future hope in preventing the vision related road traffic accidents as it is not influenced by the opaqueness of the crystalline lens. Traffic lights, sign posts and road markers in airports can be made up with flickering lights for better visibility in the individuals suffering from cataract. We need to quantify age related decrease in critical flicker fusion frequency by deducting from actual value. It is proven that there is a decrease in critical flicker fusion frequency value with increasing age. There is no change in critical flicker fusion frequency value in either sex.[23] Critical flicker fusion frequency is very much reproducible with subtle difference of training and light background. There are studies showing reduced CFFF values in case of macular degeneration. This is indicating that macula is more sensitive temporal frequencies than the static ones.[24] In myopic patients there is diminished response of ganglion cells and had low critical flicker fusion frequency values.[25] In diabetic retinopathy the ganglion call density and axonal health come down. This results in low critical flicker fusion frequency values. Glaucoma also is the ganglion cell loss.[26] Charles E. Riva et al has done study in patients with early glaucoma and ocular hypertension. They found reduced response by critical flicker fusion frequency in above patients with help of laser doppler flowmetry which detects the blood flow at the optic nerve head.[27, 34] Douthwaite WA et al found as per our conclusions that critical flicker frequency is potential visual acuity test and comparable to potential acuity meter and laser Interferometer in predicting the post operative visual outcome in patients with dense lenticular opacity.[30]

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