Research Article

# A Comparative Study of Refractive Errors with Age Related Cataract and Biometric Parameters

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**ABSTRACT:** Background: The refractive errors such as myopia and hypermetropia are greatly influenced by the cataract morphology and its biometric parameters such as axial length and corneal curvature. This study aims to determine the correlation between the refractive errors, cataract and the biometric parameters of cataract like axial length and corneal curvature. Materials and methods: This cross sectional study was carried out in a tertiary care centre. Hundred patients diagnosed with cataract were recruited for this study. The corneal curvature was measured by keratometry and axial length by A-scan ultrasonography. Cataract was classified as nuclear sclerosis and cortical cataract based on slit lamp examination, and refraction was done by autorefractometer. Results: The prevalence of myopia was considerably more among the subjects than hyperopia. There was a significantly higher prevalence of myopia in nuclear cataract. Most of the subjects with nuclear cataract were associated with myopia, and a small minority with hyperopia. Majority of the patients with cortical cataract were hyperopic. There was an increase in index myopia with increasing nuclear sclerosis. Axial and curvatural myopia account for the rest of the subjects. Axial and curvatural hypermetropia were seen in less number of subjects. Conclusion: Increase in nuclear sclerosis (index myopia) accounts for the majority of myopia. Increase in axial length (axial myopia) and increase in corneal curvature (curvatural myopia) are other determinants of myopia in patients with cataract. Similarly, hyperopia was mostly index, followed by axial and curvatural varieties.

**Keywords:** Refractive errors, Corneal curvature, Axial length, Nuclear cataract, Cortical cataract.

## INTRODUCTION

Cataract is an opacification of the crystalline lens that leads to measurably decreased visual acuity and some functional disability. Cataracts may occur as a result of aging or secondary to hereditary factors, trauma, inflammation, metabolic and nutritional disorders, or radiation. [1] Refractive error is a visual defect which prevents light from being brought to a single point focus on the retina. Because of high prevalence in the first world, refractive errors and cataract have been widely studied from different approaches. With longer life expectancies and an aging population, the burden and impact of age-related cataract are expected to increase. [2,3,4] It is clinically classified as cortical cataract and nuclear sclerosis (NS) cataract.

Myopia is usually the result of a longer than normal eyeball (axial myopia) or a steeper than normal cornea (curvatural myopia). Hyperopia usually occurs when an eyeball is shorter than normal (axial hyperopia) or when the cornea is flatter (curvatural hyperopia). [2,5] Cataract causes an increase in the refractive index of the ocular media. [2,3] It has been well documented that nuclear cataract, may lead to index myopia. [2,6,7] Nuclear cataract is the most common cause of myopic shift in refraction. [2,8,9,6] Few studies have reported a hyperopic shift or even astigmatism with cortical cataract. [4]

Axial myopia is attributed to an increase in the axial length, and curvature myopia to an increased curvature of the refractive surface of the cornea. [4,10]

The objective of this study is to search for associations between the cataract and its biometric parameters (axial length and corneal curvature), with refractive errors like myopia and hyperopia. We report the influences of cataract (nuclear and cortical) as a major determinant of refractive errors. The study provides a strong correlation between nuclear cataract and myopia, in addition to the comparison between axial length and corneal curvature as the other determinants of refractive error.

## MATERIALS AND METHODS:

This study is a population based, cross sectional study of 100 patients scheduled for cataract surgery, belonging to the age group of 45-75. The subjects were informed and consent was obtained. The study was approved by the institutional ethical committee. Inclusion criteria of this study comprises of patients with senile cataract and the exclusion criteria comprises of other varieties of cataract like metabolic cataract, traumatic cataract, complicated cataract, corneal opacity, contact lens users, pseudophakia and any previous ocular sugery.

The participants were interviewed regarding demographics, history of ocular disease or trauma, diabetes, contact lens use and previous ocular surgeries. Ocular work up included visual acuity (Snellen's chart), slit lamp, fundus examination, and refraction (autorefractometer). The corneal curvature was measured by keratometry and axial length by A-scan ultrasonography. The data collected were analysed and assessed to establish the association of refractive error with senile cataract and its biometric parameters.

The study procedure is discussed in detail as follows. All examination procedures followed a standardized protocol. Visual acuity was determined with the distance spectacle correction (if any) at initial examination, using the Snellen's chart under standard lighting conditions at 6 m. Refraction and corneal curvature were assessed with a autorefractor-keratometer. An optometrist further performed a subjective refinement and the best corrected visual acuity was determined. Both the derived refraction and the visual acuity were recorded. The autorefractor-keratometer reported three separate estimates of corneal radius of curvature along two meridians, each 90° apart. A mean value along each meridian was recorded, and the mean corneal radius of curvature was calculated as the average of the greater and lesser radii of curvature. Axial length was obtained with A-mode ultrasound device. The hard-tipped, corneal contact ultra- sound probe was used and the mean of several readings was recorded. Cataract was graded clinically using the Lens Opacity Classification System (LOCS) III system guidelines. The patients were examined at slit lamp, and the presence and grading of lens opacity were compared and documented. A gradable cataract was defined as LOCS III grade 3 or more in Cortical and/or Nuclear and/or a grade 2 or more posterior subcapsular cataract (PSC). Nuclear cataract was graded from NS I – NS IV. A spherical-equivalent of refraction equal to or more than -0.50 dioptre (D) was defined as myopia. The cut-off for hyperopia was considered to be +0.50 D and the range between -0.49 and +0.49 D was defined as normal. The prevalence rates of refractive errors based on the type of cataract were calculated in percentages.

## RESULTS

The correlation between the refractive errors (myopia and hyperopia) and the different types of cataract (nuclear and cortical) is summarized in Table 1.

| | Axial length | Corneal curvature | Nuclear cataract | | | | Cortical cataract | Overall percentage |
|---|---|---|---|---|---|---|---|---|
| | | | NS-I | NS-II | NS-III | NS-IV | | |
| MYOPIA | 10% | 17% | - | - | 34% | 39% | - | 79% |
| HYPEROPIA | 14% | 4% | 5.58% | 5% | - | - | 71.42% | 21% |

Table 1: Correlation between Refractive Errors and Cataract

Regardless of the type of cataract, the prevalence of myopia and hyperopia among subjects affected by cataract was 79% and 21% respectively.
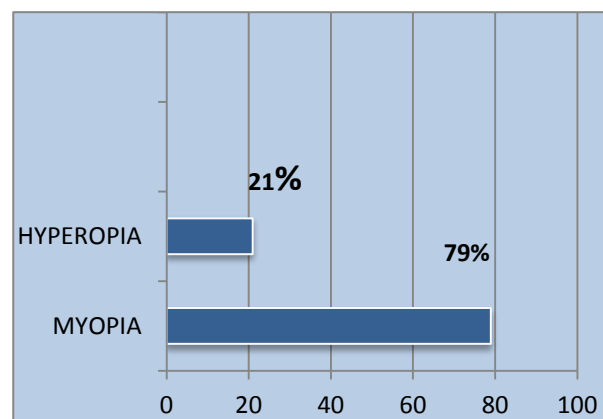


*Fig 1: Prevalence of myopia and hyperopia in cataract*

(Fig 1) The prevalence of hyperopia was significantly lower in subjects with cataract.

The prevalence of categories of myopia like index myopia, curvatural myopia and axial myopia were 73%, 17% and 10% respectively.
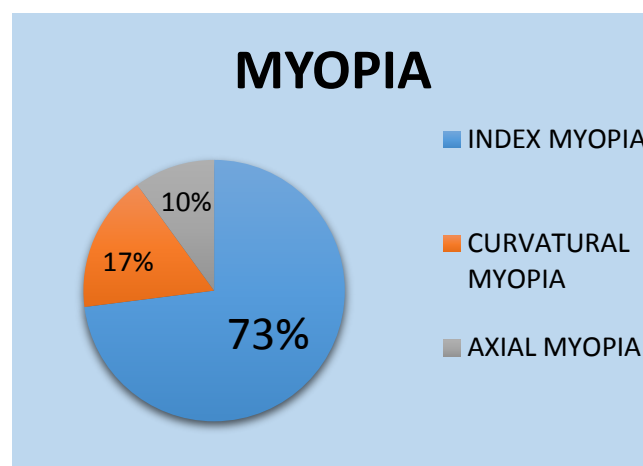


*Fig 2 . Prevalence of categories of myopia*

(Fig 2) There was an increase in index myopia as compared to other types of myopia due to increase in the prevalence of nuclear cataract. Statistical chi square tests showed that the prevalence of myopia was significantly higher among subjects with increasing degrees of nuclear cataract.
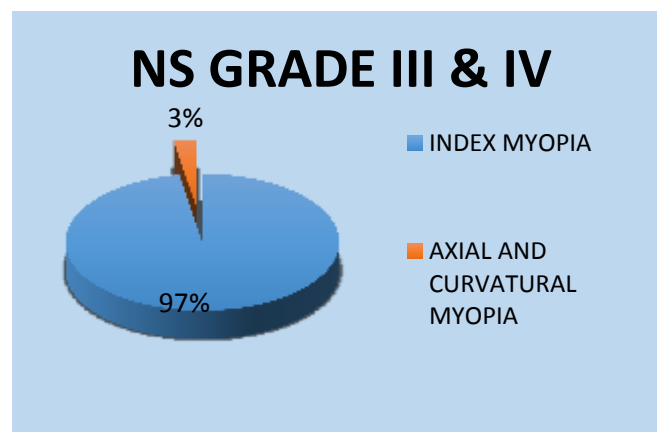


*Fig 3: Prevalence of index myopia in higher grades of nuclear sclerosis*

(Fig 3) Categorization of hyperopia as index, curvatural and axial accounted for 71.42%, 4% and 14% respectively.

## HYPEROPIA

29%

71%

■ INDEX HYPEROPIA (Cortical cataract)
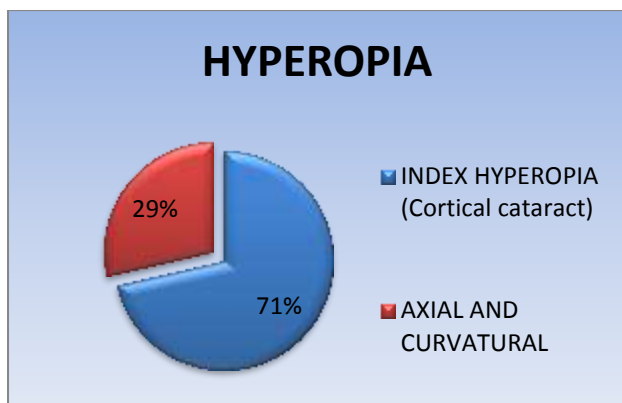
■ AXIAL AND CURVATURAL

*Fig 4. Prevalence of categories of hyperopia*

(Fig 4) 71.42% of those with cortical cataract were hyperopic.

The mean spherical equivalent in those with grade 1 nuclear sclerosis (NS) was 0.33 D, and there was a shift toward myopia, as the grade of nuclear cataract increased. The mean spherical equivalent was -2.92 D with grade 5 nuclear cataract ($P < 0.001$). In cases of posterior subcapsular cataract, the spherical equivalent varied significantly with the grade of cataract ($P = 0.002$), but the change was not linear. The mean spherical equivalent did not change significantly with different grades of cortical cataract ($P = 0.869$). As shown, the risk of myopia significantly increased as the grade of nuclear cataract increased (*P=0.000*).There was increase in index myopia in cases of NS III and NS IV cataracts (*P=0.000*). The hyperopia and cataract had an association p value 0.000.

## DISCUSSION

The association of refractive errors with lens opacity and biometric parameters have been well established. We present our analysis, in an attempt to reestablish the association between refractive errors and different types of cataract, axial length and corneal curvature.

The mechanism of cataract formation is multifactorial. Oxidation of membrane lipids, structural or enzymatic proteins by peroxides or free radicals induced by ultraviolet light may be early initiating events, that lead to loss of transparency in both the nuclear and cortical lens tissue. [1] Refractive errors occur when the curvature of the cornea is abnormal or when the axial length of eyeball is abnormal. When the axial length is normal and the cornea is of normal curvature, it refracts light on the retina with precision. Any abnormality in these parameters refracts light imperfectly on the retina, which results in blurring of vision. [2,5] Based on these abnormal biometric parameters, both myopia and hyperopia can be axial or curvatural.

It has been well documented in population-based studies that nuclear cataract may lead to a myopic shift in refraction in the elderly. [2,6,7] Based on reports by Mitchell, Chang, Fotedar and Wong, nuclear cataract is the most common cause of myopic shift. [2,8,9,6] A hyperopic shift or even astigmatism has been associated with cortical cataract. [4] Cataract causes increase in refractive index resulting in index myopia. [6] The main structural difference between hyperopic

and myopic eyes is the axial length, which is higher for myopic eyes. There are discrepancies amongst the various studies with respect to the corneal radius of curvature (CR) and optical aberrations in myopic and hyperopic eyes. [10] Some studies found significant correlations between CR and myopic or hyperopic refractive error, or significant differences across refractive groups. [10,11,12] The ratio of the axial length to corneal radius of curvature (AL/CR) appears to be negatively correlated with refractive error, stronger than CR itself in both hyperopes and myopes. [4,10]

The refractive errors and age-related cataracts are common ocular conditions. A more relevant issue is whether refractive errors are risk factors for cataract. Anecdotal evidence and clinic-based studies have suggested that myopia, particularly severe and pathologic myopia, may increase the risk of cataract. [13,14,15]

There are some limitations in our study, which should be considered when results are compared with other studies. The most important limitation is the cross-sectional design, which does not allow us to determine the causal effect of different cataract types on the prevalence of refractive errors. Only the association of these two variables can be demonstrated.

Another limitation was the cut-off points used to define refractive errors and the types of cataract. However, our main objective was to find any possible association between these two variables and not their own estimation in the patients, and, thus, the definition seems to have a limited effect on the association.

Myopia and cataract:

The study supports the well known association between myopia and cataract. The prevalence of myopia is higher in subjects with nuclear cataract. [3] Some studies have shown increasing hyperopia with age. [2,9,16] However, this association is difficult to explain and has been attributed in part to increasing lens power, due to increasing density of the lens nucleus with age. [17] The increase in hyperopia was not as high as expected for subjects older than 60 years, probably due to the myopic effect of nuclear sclerosis type of opacity. [7]

Some studies have suggested that nuclear cataract affects the density of lens nucleus with an increased gradient index. This increase in the refractive index contributes to the myopic shift in refraction. [2,6,18]

The landmark studies like Beaver Dam Eye Study and the Blue Mountains Eye Study point towards the occurrence of cataract in different types of refractive errors, and state that myopia is a risk factor for cataract. [2,6] Hence there is sufficient evidence in literature to indicate a correlation between myopia and cataract. Owing to the cross-sectional design of our study, it is not possible to detect the myopic shift which occurs over time, as a result of increasing severity of nuclear sclerosis. However, other studies support this association. In Blue Mountains Eye Study report, Guzowski

and atle showed that increase in grades of nuclear cataract, especially grades 4 and 5, are associated with -0.34 D myopic shift. Gudmundsdottir and atle state an association of -0.65 D myopic shift, five years after the diagnosis of a grade 2 or higher nuclear cataract. [2,10,18,19]

Hyperopia and cataract:

Our results indicate that hyperopia was significantly lower in subjects with cataract. This is due to the increase in nuclear sclerosis leading to myopic shift, in the majority of older subjects with cataract. Also, no significant correlation was observed between hyperopia and different types of cataract. However, the high percentage (71.42 %) of hyperopia in subjects with cortical cataract is noteworthy, similar to some other studies. From the biologic perspective, cortical cataract tends to alter the composition of the lens in a manner, which leads to a decreased refractive index. [16]

Studies on this issue have produced conflicting results. Some studies indicate that the correlation between cataract and hyperopia is weaker than with myopia, and some authors showed that hyperopia is correlated with nuclear cataract. [6,20,21] Other studies confirm the correlation between hyperopia and lower grades of nuclear cataract. [9] In our study, hyperopia seemed prevalent among cases with grade 1 and grade 2 nuclear cataract (10.58%), but this correlation was not observed with other grades of cataract. [16] These observations are in agreement with the results of other studies concerning the correlation between low-grade nuclear cataract and hyperopia. [9]

## CONCLUSION

This study demonstrates an association between cataract and refractive errors. Nuclear sclerosis grade 3 and grade 4 showed a significantly higher prevalence of myopia (index myopia). The prevalence of hyperopia was lower in nuclear sclerosis and was restricted to lower grades of nuclear sclerosis (Grade 1 and 2). Greater degrees of index myopia was associated with higher grades of nuclear cataract. Significant correlation was found between cortical cataract and hyperopia. However, further studies with a larger sample size are indicated to reevaluate this correlation and provide a comprehensive causal association.

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