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Prevalence of Refractive Error Changes in Nuclear and Cortical Cataract

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Abstract:
Purpose:*To evaluate the prevalence of refractive error changes induced by nuclear and cortical cataract.*
Background:*Refractive error results from the failure of optical system of the non-accommodating eye to bring the parallel rays of light into focus on the fovea. Nuclear cataract is associated with index myopia and cortical cataract is associated with index hyperopia.*
Methodology:*The sample population consists of 100 patients with cataract presenting in a tertiary care hospital in Puducherry.The patients were screened for defective vision using Snellen's chart. Keratometer was used for measuring corneal curvature and UltrasoundA scan for axial length.Slitlamp examination was done to classify cataract as nuclear and cortical.*
Results:*The mean age group was 55±10 years. The prevalence of myopia and hyperopia was 78% and 22% respectively. Myopic astigmatism and hyperopic astigmatism were seen in some cases. Myopia was further categorised as low (50%), moderate (38%) and high (12%). Hyperopia was classified as low (72%), moderate (28%) and high (0%). Astigmatism was seen in 34%.*
Conclusion:*The most prevalent refractive error induced by cataract was myopia and most of the patients with nuclear cataract showed myopic shift. High myopia is associated with higher grades of nuclear sclerosis. High prevalence of hyperopia is seen in cortical opacities.*
Keywords:*Refractive error, nuclear cataract, myopia, cortical cataract, hyperopia.*

I. Introduction

The relationship between refractive errors and age related cataract is oversimplified. Studies suggest that high myopia may be seen in association with the development of nuclear sclerosis, but less is known regarding the association with mild and moderate levels of myopia. [1] Cataract is the most common treatable cause of blindness in the developing economies. About 3.8 million people in India become blind due to cataract every year. Studies from urban India suggest that 49.3 million population above 15 years of age may have refractive errors, many of which remain undiagnosed. [2]

A refractive error may result from the failure of the optical system of a non- accommodating eye to bring parallel rays of light to focus on the fovea. Myopia and hyperopia are the refractive errors in which the optical system of the eye brings parallel rays of light into focus, anterior and posterior to the fovea respectively, resulting in blurred vision. Mild to moderate hyperopia in childhood and early adulthood may be overcome by accommodation. Myopia results in blurring of vision at all ages. Nuclear cataract is the most common cause of myopic shift. [1,3,4] The relationship between the other types of cataract and refractive errors is still not clearly understood. While many studies have confirmed the association between myopia and nuclear cataract, few have reported hyperopic shift or astigmatism with cortical cataract. [4,5,6,7,8]

Refractive errors serve as a major cause of mild to moderate visual impairment in the population. Hence knowledge about the prevalence of refractive errors and the importance of prompt diagnosis would be helpful in planning public health strategy. The refractive status of the eye changes with increasing age. This partly attributes to the changes in the crystalline lens with age. [2] The purpose of this study is to evaluate the prevalence of myopia and hyperopia induced by cataract, in a tertiary care hospital at Puducherry.

II. Methodology

A cross sectional study was done among the elderly patients with cataract visiting the outpatient department of a tertiary care hospital in Puducherry, from October 2015 to March 2016. The subjects were recruited from the patients presenting with cataract. Informed consent was obtained from all the subjects, after explaining the study in their vernacular language. The study was approved by the institutional ethics committee. The study population includes hundred patients belonging to the age group of 55±10 years. Patients with age related cataract of any morphological type were included in the study. The patients with aphakic and

pseudophakic eyes were excluded. The other ocular abnormalities causing visual loss such as corneal opacity, glaucoma, Age Related Macular Degeneration and optic atrophy were also excluded.

The determination of refractive error in cataract patients was mainly based on visual acuity by Snellen's chart and subjective refraction from autorefractometer reading, followed by measurement of corneal curvature and axial length. Keratometer is used to quantify the radius of curvature of cornea in horizontal and vertical meridian, which is measured simultaneously without rotating mires. Subjects with corneal curvature greater than or equal to 44D were grouped as 'steeper corneas', as seen in myopes. The subjects with corneal curvature less than or equal to 42D were categorised as 'flatter corneas', as observed in hyperopes. The axial length of the eye was measured using Ultrasonic A scan. The axial length was 'longer' (≥24mm) for the myopic eyes, compared to 'shorter' axial length (≤22mm) for hyperopic eyes. The myopia was further categorised into low (>-3D), moderate(-3D to -6D) and high(<-6D). Similarly, hyperopia was classified into low (<+2D), moderate(+2D to +5D) and high(>+5D).

Because of high correlation between right and left eyes in the majority screened, only data from the right eye were analysed. The prevalence rates of refractive errors according to the type of cataract were calculated in percentages. The refractive status was defined based on subjective refraction, corneal curvature and axial length. For analysis, myopia was defined as the spherical equivalent more than - 0.5 dioptre and hyperopia was defined as the spherical equivalent more than + 0.5 dioptre. Cataract was defined based on slit-lamp grading of the lenticular opacities and classified into nuclear and cortical cataract.Nuclear sclerosis was further classified into four grades.

III. Results

The mean age group was 55±10 years and 42% were female. Prevalence of myopia and hyperopia was 78% and 22% respectively. Prevalence of hyperopia significantly increased with age whereas myopia showed no significant correlation with age ($p<0.01$). The axial length and the corneal curvature correlation is significant at 0.01 level.

3.1. Distribution of myopia and heperopia (Fig 1)

The prevalence of myopia is found to be greater in subjects with nuclear cataract. The increase in the prevalence of hyperopia is not as high as expected,probably due to the myopic shift of the nuclear cataract in the majority of patients. The higher percentage of hyperopia is seen in adults with cortical cataract. There was no significant gender predilection.

3.2. Prevalence of myopia and hyperopia in nuclear and cortical cataract (Fig 2)

Amongst the 78 subjects with myopia, only two were seen associated with cortical cataract and 76 were associated with nuclear cataract. In contrast to this, out of 22 hyperopes, 21 were associated with cortical cataract and only one case was seen in nuclear cataract.

3.3. Prevalence of astigmatism

Astigmatism was seen in about 34% of the subjects. Astigmatism was generally seen in combination with myopia and hyperopia, as myopic astigmatism (14%) and hyperopic astigmatism (20%) respectively. The hyperopic astigmatism was more prevalent among the subjects than myopic astigmatism. The prevalence of astigmatism was mostly seen among the patients with cortical cataract. This may be due to cataract induced astigmatism (CIA).

3.4.Categorisation of myopia (Fig 3)

Myopia is further categorised into low myopia (< -3D), moderate myopia (-3D to -6D) and high myopia (> -6D). High myopia is associated with higher grades of nuclear cataract. The prevalence rates of low, moderate and high myopia are 50%, 38% and 12% respectively.

3.5.Categorisation of hyperopia(Fig 4)

Hyperopia is further grouped into low(<+2D), moderate(+2D to +5D) and high (>+5D). The prevalence rates of low and moderate hyperopia are 72% and 28%respectively(Fig 1). There was no case of high hyperopia in our study.

IV. Discussion

Refractive errors and age related cataract are common ocular conditions affecting normal vision. Prevalence of myopia and hyperopia in our study were 78% and 22% respectively. (Fig 1) The Blue Mountain Eye Study correlated refractive errors and age-related cataract in an Australian population.[7]Refractive errors

could be the cause or the consequence of the cataract. Early-onset myopia, defined as a self-reported history of distance spectacle use before 20 years of age, was associated with a four times higher odds of posterior subcapsular cataract detected during the survey, where participants were between 49 to 98 years of age. A study suggests that posterior subcapsular cataract is also related to a deeper anterior chamber, thinner lens, and a longer posterior segment, and that adjusting for these components, attenuates the association of posterior subcapsular cataract (PSC) with myopia substantially.[9] Cataract often associates with myopia,especially nuclear cataract.[10] Lens changes were highly prevalent (42%) in the black participants of Barbados eye study, with cortical opacities (34%) being most common, followed by nuclear (19%) and posterior subcapsular opacities (4%).[11] Our study reports nuclear cataract to be more common than cortical and is associated mostly with index myopia. (Fig 2)

After controlling for other types of opacities, nuclear opacities were associated with a higher prevalence of myopia and a lower prevalence of hyperopia. To a lesser degree, posterior subcapsular opacities were also associated with a higher prevalence of myopia. Modest associations of refractive errors and cortical opacities were seen, in contrast to those of nuclear and PSC opacities. These association patterns can possibly be explained by the different morphological location and sclerosis of the various types of opacities.

Tehran eye Study showed that the risk of myopia is 1.81 times greater in subjects with nuclear cataract.[12] Gudmundsdottir and colleagues studied thefive -year refractive changes in population over 50 years of age and found no correlation.[13] However, contrasting to this observation, the Blue Mountains Eye Study indicated higher prevalence of myopia in cases of cortical cataract. [14]

Premaet al showed that the association between myopia and age almost disappeared, after adjustment for nuclear sclerosis, indicating that the nuclear sclerosis is responsible for increase in myopia with age.[7]This is in contrast to our study, where no such increase in myopia with age was seen. This is possibly caused by the symmetrical refractive index changes within the nucleus of the lens, causing negative spherical aberration and a myopic shift.[1,3,5] It is seen that there may be a slight myopic shift in some patients with cortical cataract and is probably due to early nuclear cataract associated with it, rather than cortical opacity itself.[1]

Environmental influences and racial differences in tropical countries such as India, contribute to early sclerosis of the crystalline lens and consequent myopia.[2] Studies have shown positive correlation between nuclear cataract and index myopia.[8,14,15]They suggest that the nuclear cataract affects the density of the crystalline lens with an increased gradient index. These changes increase the refractive index and cause a myopic shift.Our study similarly proves a strong association between nuclear cataract and index myopia, and myopia is graded as low, moderate and high. (Fig 2 and 3)

In the Blue Mountains Eye Study conducted among 3,654 participants aged more than50 years in Australia, the prevalence of anisometropia in participants with bilateral cataract, unilateral cataract and those without any cataract, were 24.9 %, 18.2 % and 9.1 % respectively. [7] There was less prevalence among participants with unilateral cataract compared to those with bilateral cataract. Cataract causes changes in therefractive index of the lens, which consequently influences the refractive error. It is hypothesised that the prevalence of anisometropia might be highest among the participants with unilateral cataract. On the other hand, in bilateral cataract, it is probable that the progression or the type of lenticular opacity is different in the two eyes and therefore, the prevalence of anisometropia is greater among them compared to individuals without cataract.[16]

The study from urban India by Dandona et al showed similar prevalence of myopia in the age group of 45-50 years, but its prevalence was comparatively lesser in older age groups.[17] Our study shows a positive correlation between cortical cataract and hyperopia and hyperopia is classified as low, moderate and high. (Fig 2 and 4) We are unable to explain the association between the hyperopia and incident nuclear or cortical cataract. In previous analysis, the association between thinner lens and cortical cataract is well established.[5]

A significant astigmatic shift may be seen with cortical cataract. Astigmatic shift may be due to Cataract Induced Astigmatism (CIA) and may be partly explained due to corneal changes. The mechanism by which cortical cataract induces astigmatism is not clear.[18] It may be postulated that the astigmatism is due to changes in lens curvatureandthickness of the lens. The Cataract Induced Astigmatic shift in refractive index is caused due to the asymmetrical refractive index changes within different parts of the cortex of the lens.[18] Slight CIA is seen in patients with nuclear cataract and it may be partly explained by the coexisting early cortical opacity.

Fotedar and colleagues presented the evidence of significant hyperopic shift among the patients without nuclear cataract.[4] Based on previous studies,we infer that cataract might cause elongation of the axial length in adults with myopia. This result has challenged the general accepted rule that the axial length is stable in adults. It iswell known that the two basic mechanisms by which animalmyopia may be induced are form deprivation and optical defocus. The cataract can cause both form deprivation and optical defocus, predisposing to a myopic shift in refractive status.[19]

There are certain inherent limitations in our study. In a cross-sectional study, we cannot infer a temporal relationship between any of these factors. Secondly, selection bias must be considered because some people were excluded since they did not have a biometric examination or had mature cataract, for which they had undergone cataract surgery.

The prevalence of myopia was 78% and increased significantly with age.(Fig1) This relationship was due to the confounding effect of nuclear sclerosis. Prevalence of hyperopia increased until 70 years of age and then decreased. It may be probably due to the effect of myopic effect of nuclear cataract.[1,4,5] It was interesting to note that similar patterns have been observed in those studies conducted in the tropical regions,whereas those observed in the temperate regions were different.[5] This difference elucidates that environmental influences may play a role in the prevalence of cataract induced refractive errors in older population.[5]

V. Conclusion

This study suggests that most of the patients with nuclear cataract showed a significant myopic shift. High myopia is seen associated with higher grades of nuclear sclerosis cataract. Although there was no significant correlation between the hyperopia and cortical cataract, high prevalence of hyperopia is seen in cortical opacities. Cataract Induced Astigmatism is caused due to the asymmetrical refractive index changes within different parts of the cortex of the lens.

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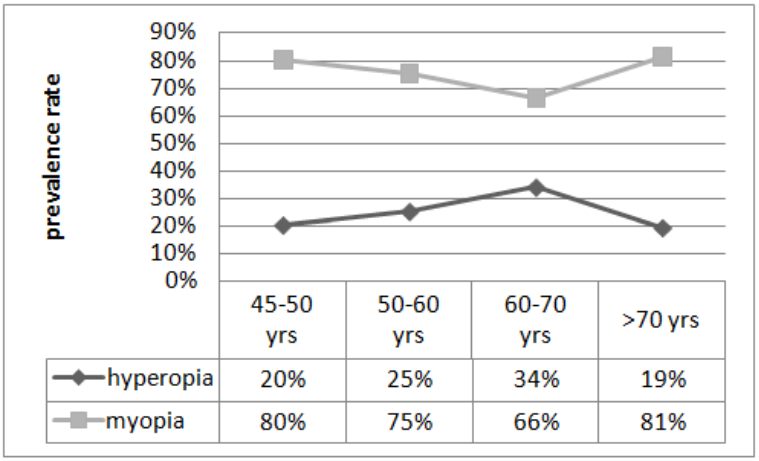

Figure 1. Prevalence rates of myopia and hyperopia

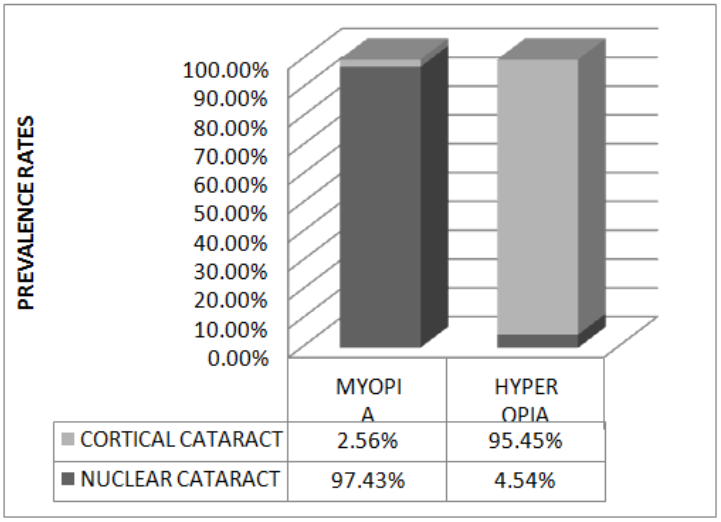

Figure 2.Prevalence of myopia and hyperopia in cortical and nuclear cataract.

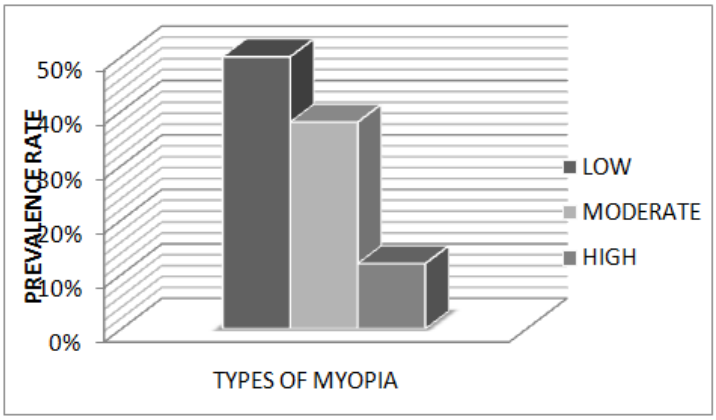

Figure 3. Prevalence rates of types of myopia.

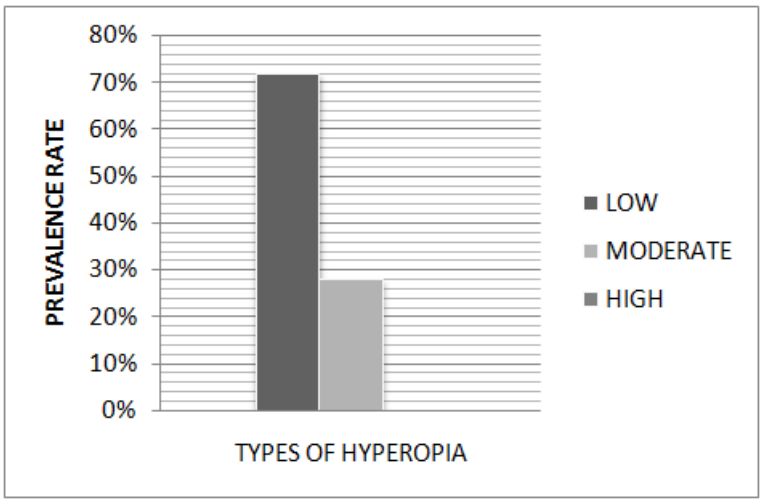

Figure 4. Prevalence rates of types of hyperopia.