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Original Research Article

Prospective, Comparative Assessment of Nuclear Size in Mature and Hypermature Cataract

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Abstract

Aim: To study Comparison of nuclear size in mature and hypermature cataract.

Materials and Methods: This prospective, comparative study conducted in the Department of Ophthalmology, Nalanda medical College and Hospital Patna, Bihar, India, for 1 year. The inclusion criteria were patients with senile white cataract opting to undergo MSICS technique, and uneventful surgery. Only cases with intact nuclei after removal were taken up for further evaluation.

Results: The mean axial length (23.96mm + 0.68 in mature and 24.05 + 0.96 mm in hypermature group), central corneal thickness (519.9 + 48 vs. 519.1 + 20) and AC depth (3.12 + 0.59 vs. 3.02 + 0.50) in both the groups were comparable. Average lens thickness in mature cataract group was 4.40mm (+ 0.56, range 3.39-5.39) while in the hypermature group it was 3.80mm (+ 0.30, range 3.11- 4.32). The average lens thickness differed significantly between the two groups. The average nuclear thickness was 3.67 mm (+ 0.40, range 3.18-4.39) in mature vs. 3.37 mm (+ 0.31, range 2.67- 3.96) in the hypermature group. This difference was statistically significant. The average nuclear diameter in mature group was 7.56mm (+ 0.53, range 6.57-8.50) and in hypermature group was 7.37 mm (+ 0.43, range 6.36-8.08). The nuclear diameter did not differ significantly between two groups (p=). The ratio between nuclear thickness and lens thickness was similar in both groups (0.83 in mature and 0.90 in hypermature group). The thickness to diameter ratio of nucleus also was similar in both the groups (0.49 + 0.03 in mature and 0.47 + 0.03 in hypermature).

Conclusion: The lens and nucleus in mature cataract are thicker than hypermature cataract thus indicating need to use higher machine parameters. On the other hand the lens and nucleus are thinner in hypermature cataract. This requires lower setting of parameters during phacoemulsification.

Keywords: Cataract, Lens, Nucleus

Introduction

Cataract is one of the most common causes of visual impairment in the world. According to the World Health Organisation (WHO), cataract is the leading cause of blindness all over the world, responsible for 47.8% of blindness and accounting for 17.7 million blind people.[1,2]In India, 80% of the blindness is due to cataract.[3,4] Various modifiable risk factors associated with cataract include UV exposure, diabetes, hypertension, body mass index (BMI), drug usage, smoking and socioeconomic factors; but advancing age is the single most important risk factor for cataract.[5–13]

Nirmalan et al. studied the prevalence of cataract in a rural population (≥40 years) of Southern India and reported the presence of cataract in 47.5% of their study population, prevalence being less in men compared to women.[14] In a recent population, Vashist et al. reported prevalences of 58% in North India and 53% in South India in the older age group (>60 years) with nuclear cataract being the most common type of cataract in both parts of the country.[15]

In India, a very few population based studies have been undertaken to explore the risk factors for cataract in older age group, especially since the proportion of the elderly has been significantly increasing in the country; the 60 + population which stood at 56 million in 1991 is now estimated to have doubled in 2016.16 The aim of the present study was to examine a proportionate sample of both rural and urban population ≥60 years and to report the age‐ and gender‐adjusted prevalence rates of cataract in the population, and examine associated risk factors.

Material and methods

This prospective, comparative study conducted in the Department of Ophthalmology, Nalanda medical College and Hospital Patna,Bihar, India, for 1 year.

The inclusion criteria were patients with senile white cataract opting to undergo MSICS technique, and uneventful surgery. Only cases with intact nuclei after removal were taken up for further evaluation.

Exclusion criteria were set as presence of complications of white cataract, incomplete preoperative workup, like non-availability of slit lamp findings, poor mydriaisis, complicated cataract, chipped or broken nucleus, previous intraocular surgeries. The cases were excluded if measurement of nuclear size was not carried out within two hours of removal of nucleus.

Methodology

Preoperatively, after dilating the pupil the type of white cataract was evaluated by noting following factors in slit lamp: Color of the lens, depth of the anterior chamber, bulging of anterior lens capsule into pupillary plane, presence of sunken nucleus, phacodonesis. The cataract was classified as mature or hypermature depending on the findings. Intumescent white cataract was considered as a type of mature cataract for this study. The diagnosis had to be modified during surgery in a few cases as presumptive mature cataracts turned out to have liquefied cortex as major component.[16]

The ocular dimensions were measured using immersion biometry during preoperative intraocular lens calculation. Alcon Ocuscan RxP A-scan machine in immersion technique mode was used for this purpose. Mean of ten readings was taken and the standard deviation was kept less than 0.05 for accepting the readings. Axial length (AL), anterior chamber depth (ACD) and lens thickness (LT) were thus obtained. The central corneal thickness (CCT) was recorded using same machine by ultrasound pachymetry.

The cataract surgery was performed using phacos and wich technique for MSICS as described previously to obtain an intact nucleus. [17,18]

In this study we used an app named "ON ruler" version 2.0 (the App) to measure the nuclear dimensions. This is a free app, and provides two pairs of lines to assess length and breadth of physical objects simultaneously in millimeters. [15] The app provides measurement values up to three decimal points taking accuracy to micrometer level. The app has to be calibrated once by comparing against a known length. A 2.2 mm keratome (Alcon labs) was used for this purpose and measurement unit of one millimeter was calibrated. This setting was used throughout the experiment. The same procedure was carried out before every measurement.

A simple method was developed to measure the dimensions of the nucleus. After wiping loose lens fibers from surface of the nucleus with gauze piece, the nucleus was rinsed and wiped once more. Measurements were carried out on this relatively dry nucleus.

Measurement of diameter:

The microscope was set at 0.6x magnification with 10x ocular without switching on light. The background illumination of smartphone was set to maximum. The App was launched and four-crosshair option was selected. The nucleus was placed in the center of the screen with anterior surface (flatter surface) in contact with the screen. The vertical (Y-axis) and horizontal (X-axis) pairs of lines were adjusted while observing under microscope with mono-ocular view. Right ocular was used throughout the study to maintain uniformity and to avoid parallax error. Values along x and y-axes were recorded up to three decimal points. The procedure was repeated 3 times and average was taken as final value. The nucleus was skewered adjacent to its center using a 26G needle on 10cc syringe holding the syringe vertically. This nucleus mounted on 26G needle was placed with its equatorial edge touching the screen so that its thickness could be measured. The measurement was taken similar to measuring diameter but only in one axis. The syringe was rotated 900 on its axis and thickness of nucleus was measured again. Average of these two measurements was taken as thickness of the nucleus.

Statistical analysis

The data thus obtained was entered into SPSS software (version 25.0, IBM Inc. Chicago, Illinois) for analysis. Descriptive statistics were presented as mean and standard deviations. Unpaired T-Test was used for comparison of between group variations. The level of significance was set at $P<0.05$ across all parameters.

Results

In this prospective observational study, eighteen mature and sixteen hypermature senile cataracts were analyzed over six months period. In the mature cataract group, the mean age was 63.18 + 11.40(range of 45 to 80 years) ; the sex ratio was equal. In the hypermature cataract group mean age was 65.8 + 14.0 years (range 45 to 87 years); 14 out of 20 patients were female (70%).

Table 1: Comparison of Ocular parameters between mature and hypermature group

	Mature cataract		**Hypermature cataract**	
Measurement (mm)	Mean	Std. Dev	Mean	Std. Dev
Axial length	23.97	0.68	24.05	0.96

CCT	519.9	47.7	519.2	19.7
AC depth	3.14	0.59	3.04	0.50
Lens thickness	4.42	0.56	3.82	0.32
Nuclear thickness	3.67	0.40	3.37	0.31
Nuclear diameter	7.56	0.53	7.37	0.43
Nucleus/Lens thickness	0.83	0.12	0.90	0.09
Thickness/ diameter of nucleus	0.49	0.03	0.47	0.03

Table 2: Comparison between mature and hypermature groups (unpaired T-Test)

Mature vs. Hypermature cataract	p value
Age	0.53
Avg Axial length	0.78
Lens thickness	0.0004
Nuclear thickness	0.02
Nuclear diameter	0.30
Nuclear thickness/Lens thickness	0.27

The ocular parameters for the two study groups are listed in Table 1. The mean axial length (23.96mm + 0.68 in mature and 24.05 + 0.96 mm in hypermature group), central corneal thickness (519.9 + 48 vs. 519.1 + 20) and AC depth (3.12 + 0.59 vs. 3.02 + 0.50) in both the groups were comparable. Average lens thickness in mature cataract group was 4.40mm (+ 0.56, range 3.39-5.39) while in the hypermature group it was 3.80mm (+ 0.30, range 3.11- 4.32). The average lens thickness differed significantly between the two groups (p= Table 2). The average nuclear thickness was 3.67 mm (+ 0.40, range 3.18-4.39) in mature vs. 3.37 mm (+ 0.31, range 2.67- 3.96) in the hypermature group. This difference was statistically significant (p=). The average nuclear diameter in mature group was 7.56mm (+ 0.53, range 6.57-8.50) and in hypermature group was 7.37 mm (+ 0.43, range 6.36-8.08). The nuclear diameter did not differ significantly between two groups (p=). The ratio between nuclear thickness and lens thickness was similar in both groups (0.83 in mature and 0.90 in hypermature group). The thickness to diameter ratio of nucleus also was similar in both the groups (0.49 + 0.03 in mature and 0.47 + 0.03 in hypermature). Significance levels for different parameters between the two groups are listed in Table 2.

Discussion

The varying difference in the prevalence of a cataract could be due to various reasons including differences in ethnicity, age group of the population and also the variability in the cut‑off point adopted within the LOCS III system to define the presence of cataract. The studies from Indian subcontinent have reported a higher prevalence of cataract; Aravind Comprehensive Eye Study (ACES) in 2003 reported the prevalence of cataract among people >40 years to be 47.5%, and the INDEYE study in 2011 reported the prevalence to be 58% in North India and 53% in South India, respectively.[19,20]

It is difficult assessing the density and size of nucleus in white cataract. Conventionally it is believed that hypermature stage follows mature stage. Cases with significant cortical component progress to hyper maturity. In the present study two factors were noticeable. The nuclear thickness was significantly more in mature than hypermature cataracts while nuclear diameter was similar. The lens

thickness was significantly more in mature cataract than hypermature cataract but the nuclear to lens thickness ratio did not differ significantly between the two groups. A thick nucleus with significantly thicker lens thus could be seen in mature cataract as compared to hypermature cataract. Thicker lens and thicker nucleus in presence of similar nuclear diameter and comparable nucleus lens ratio is suggestive of the nucleus of mature cataract occupying larger volume. In hypermature cataract one can expect more of liquefied cortex than a large nucleus. These findings are in line with conventional view that cortical cataracts progress more commonly to hypermaturity than nuclear cataracts.

However, the nuclear thickness differs significantly between mature and hypermature cataracts, the nuclear diameter remain same in the two groups. Thus there seems to be increase in nuclear thickness than diameter as cataract advances to late stages.

Among the three types described by Brazitikos et al in their study, type I with liquefied cortex and type III with fibrosed shrunken capsule would fit into clinical definition of hypermature cataract.[21] Type II was described with “voluminous” nucleus and solid cortex, and would fit into definition of mature cataract. In this study though the two clinical types of mature and hypermature cataract were used. The finding of larger nuclear and lens thickness in mature cataract than hypermature cataract agrees with the findings of Brazitikos et al. They also noted higher mean phacoemulsification time and energy in type II and type III white cataracts. Thus it is logical to conclude that the larger nucleus seen in mature cataract usually is denser and can have more chances of complications in phacoemulsification. A preoperative knowledge of the nuclear thickness would be helpful to surgeon to plan proper technique and fluidics parameter to use for these difficult cases. Some cases always end up in the other group than the preoperative diagnosis. Thus it is better to prepare for phacoemulsification of mature cataracts in case of white cataracts, as mature cataract would have thicker and denser nucleus and minimal epinuclear support. It should also be noted that the nucleus in hypermature cataract can be quite thin (lowest value of 2.66 mm in present study) and emulsification parameters adjusted accordingly.[22]

Day et al study covering 180 thousand eyes from 28 centers in the United Kingdom concluded that white cataracts are more common at extremes of age. But in our study the mean axial length in both groups was in normal range with all the eyes within 22-26 mm range. The possible reason for this disparity could be small sample size of present study and higher prevalence of white cataract in India.[23,24]

Conclusion

The lens and nucleus in mature cataract are thicker than hypermature cataract thus indicating need to use higher machine parameters. On the other hand the lens and nucleus are thinner in hypermature cataract. This requires lower setting of parameters during phacoemulsification.

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