Original Article

Correlation of Dysfunctional Lens Index with Lens Opacification System III in Age Related Cataract

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ABSTRACT

Purpose: Age-Related changes in crystalline lens opacity and lens density contribute to formation of higher order aberrations resulting in reduced quality of vision. Precise quantification of cataract is important for predicting phacodynamics and educating patient. The iTrace(a ray-tracing aberrometer) provides Dysfunctional Lens Index (DLI). This study from Pakistan investigates the relationship between LOCS III and DLI in senile cataract.

Study Design: Correlational study.

Place and Duration of Study: Hashmanis Hospital, Karachi from March 2021 to May 2021.

Methods: This study included 44 patients with age-related cataract. Demographic characteristics and complete ophthalmic examination of eyes including Best Corrected Visual Acuity (BCVA) and slit lamp biomicroscopy were performed. Age related cataracts were graded using the Standard technique of LOCS III. I-Trace was utilized for wave front analysis to calculate DLI.

Results: BCVA and LOCS III nuclear opalescence score had strongest positive linear correlation (r=0.433, P<0.01). DLI displayed a strong significant negative correlation to LOCS III Cortical Cataract (C) and LOCS III Posterior Sub-Capsular Cataract (P) score (r=-0.415 and r=-0.694; respectively).

Conclusion: BCVA had insignificant and small to no correlation to LOCS III C score and P score. Whereas, DLI showed the strongest significant correlation to LOCS III C score and P score. Patient's optical quality determined by visual symptoms are more closely associated to DLI parameter as compared to LOCS III classification. DLI can provide a better objective way to elevate age related cataract, monitor the progression and determine phacodynamics.

Key words: Aberrometry, Phacodynamics, Cataract, Phacoemulsification, Visual Acuity.

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INTRODUCTION

Cataract surgery has progressed in the recent years as refractive surgery for optimum pot-operative visual rehabilitation. Previously it was aimed to treat the disease in form of cataract removal but now the goal has shifted towards a patient-centered approach regarding management of patients' visual needs.[1] The decrease in optical function of the eye with age is a continuous process which is further deteriorated with the molecular changes occurring in age-related cataract that involves decrease in optical transparency as well as increased lens density resulting in light scattering and wave front aberrations causing disparity of retinal image.[2,3] As a result reduced quality of vision still occurs despite good visual acuity[4,5] and therefore the need to perform cataract surgery earlier has emerged for patients that demand better quality of vision.

Earlier, the threshold for cataract surgery was determined by decline in visual acuity (VA), subjective evaluation of crystalline lens opacity, visual function, patient's satisfaction with pre-operative VA and surgeon's preferred practice.[6-8] Assessment of cataract severity encompasses several modalities such as Lens Opacities Classification System III (LOCS III), wave front analysis and Dysfunctional Lens Index (DLI). LOCS III is subjective method utilizing slit-lamp biomicroscopy. It is frequently used in research to evaluate crystalline lens opacity. Although commonly used, this method has significant inter-observer bias with poor reproducibility.[3]

Wave front analysis has proved its role in objectively quantifying Higher Order Aberrations (HOA) associated with visual impairment in different types of senile cataract.[14-15] Visual Function Analyzer such as iTrace is a ray-tracing aberrometer (Tracey Technologies, Houston, TX) which is coupled with corneal topographer that gives results for total ocular aberrations via several parameters. Among these DLI is a function of objective lens performance derived from internal HOA, pupil size and contrast sensitivity data.[15] With increase in demand for premium cataract surgery and intraocular lens implantation, there is a need for sensitive and an objective method of lens performance assessment that can not only evaluate the severity of age-related cataract but can also guide in adjustment of phacodynamic parameters intraoperatively. To the best of our knowledge, this is the first study from Pakistan investigating association between LOCS III and DLI in age-related cataract.

METHODS

This was a correlational study including 44 patients with senile cataract. The study was conducted at Hashmanis Hospital Karachi from March 2021 to May 2021. Institutional review board approved the study and for each participant written informed consent was obtained. Patients with poor mydriasis, corneal opacities, media opacities (other than cataract), History of ocular surgery, any systemic disorders affecting vision, eyes with hypermature, intumescent or morgagnian cataract and coexisting ocular pathologies were excluded.

Complete ophthalmic examination was performed in each patient which included subjective monocular refraction and BCVA noted in logMAR units, contact tonometry, slit-lamp biomicroscopy and dilated fundus examination. After complete mydriasis, as per the standard technique of LOCS III[9] one set of slit lamp pictures were taken for each eye with age-related cataract. Lens photographs were taken using retro-illumination (Nidek EAS-1000; Nidek, Gamagori, Japan) and digital slit-lamp (Topcon model DC-1 with FD-21 flash attachment; Topcon, Tokyo, Japan). Grading was done utilizing intervals of 0.1-unit, assigning the opacity. The scale ranged from 5.9 (very opaque in C and P) and 6.9 (brunescent or very opaque in NC and NO) to 0.1 (clear or colorless).

Wave front analysis was done using i-Trace. In a dark room 3 measurements were taken for each eye. The device has a corneal topographer integrated with an aberrometer. Raytracing principle provides the basis for aberrometer, which successively projects laser beams of near-infrared wavelength in a precise scanning pattern into the eyes. Same device contains a Placido-based corneal topographer (Eye Sys Vision, Houston, TX) used for Topographies. Data from Topography was utilized to calculate corneal aberrations. A built-in program subtracted the aberrations provided by ray-tracing aberrometer (for complete eye) from corneal aberrations to obtain internal aberrations. The DLI was provided by wave front sensor.

i-Trace and Pentacam scans were reviewed by an experienced rater and further analysis was performed on scan with best-quality out of 3 measurements taken. Each wavefront scan was checked for centration of visual axis of the eye with measurement. Software was set to measure optical zone of 4-mm to take measurement of wavefront and DLI was noted for each included eye. The data obtained was analyzed using SPSS V.26. Means ± standard deviations were noted, Kolmogorov–Smirnov test was utilized to access normality and Pearson and Spearman correlations were calculated. P value ≤ 0.05 was considered statistically significant.

RESULTS

We included 44 eyes (22 from male and females each), and an equal proportion of left and right eyes. The age ranged from 26 to 70 years (54.14 ± 9.23 years). The BCVA logMAR grade varied from 0 to 1 and mean of 0.39 ± 0.31 was observed. Cataract characteristics and DLI are mentioned in Table 1. One fifth (20.5%) eyes had C1 cataract and 6 (13.6%) had C5 cataract, most of the patients had no cortical cataract. NO grade 3 and

Table 1: *Demographic and cataract characteristics of 44 eyes.*

Parameters	Range		Mean	Std. Deviation
	Minimum	Maximum		
Age	26	70	54.14	9.23
BCVA (logMAR)	0	1	0.39	0.31
Cortical Cataract score (LOCS III)	1	6	2.68	1.76
NO score (LOCS III)	1	6	3.20	1.13
P score (LOCS III)	1	6	2.82	1.66
DLI	0.02	9.39	4.42	2.73

BCVA = Best Corrected Distance Visual Acuity; LOCS III = Lens Opacities Classification System III; NO= Nuclear Opalescence; P= Posterior Sub-Capsular Cataract; DLI= Dysfunctional Lens Index.

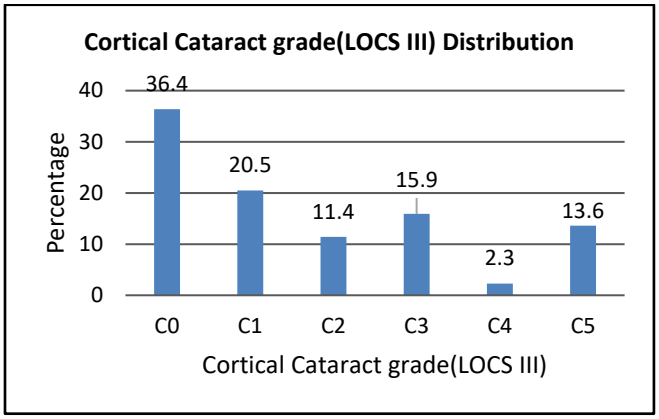

Figure 1(a): Percentage of Cortical Cataract grade utilizing LOCS III.

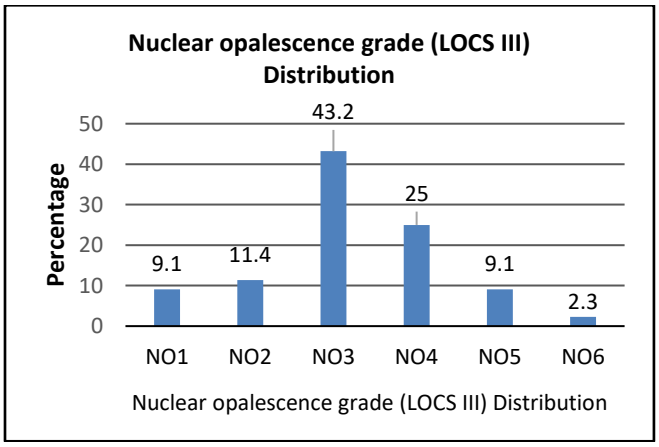

Figure 1(b): Percentage of Nuclear Cataract grade utilizing LOCS III.

P grade 1 was noted in most (43.2% and 36.4%, respectively) eyes (Figure 1).

Bivariate analysis revealed that age had statistically significant positive correlation with DLI (r=0.344) and negative correlation to LOCS III cortical cataract score (r=-0.414). No correlation of age with BCVA, LOCS III Posterior Sub-Capsular Cataract score and nuclear opalescence score was found.

A negative correlation was seen between the BCVA (logMAR) and DLI (r= -0.353, P=.019). BCVA had strongest positive linear correlation to LOCS III NO score (r = 0.433, P < .01). BCVA showed a small non-significant positive correlation with LOCS III Posterior Sub-Capsular Cataract score (r = 0.239, P=.119) and no correlation to LOCS III Cortical Cataract score (Figure 2).

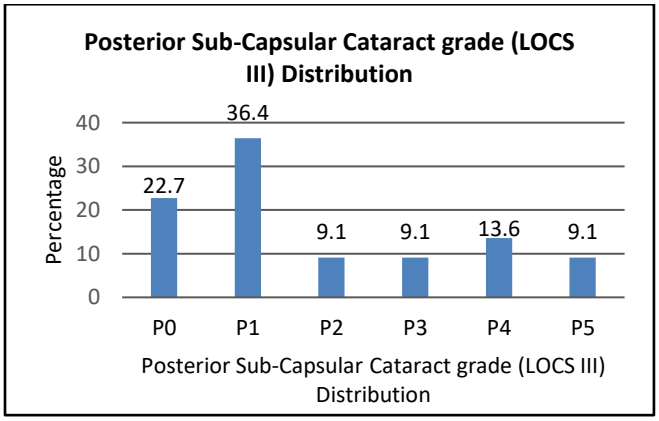

Figure 1(c): Percentage of Cortical Cataract grade utilizing LOCS III.

DLI had negative correlation to LOCS III NO score (r= -0.234, P=.126). DLI displayed a strong significant linear negative correlation to the LOCS III Cortical Cataract score and LOCS III Posterior Sub-Capsular Cataract score (r= -0.415 and r= -0.694; respectively) (Figure 2).

DISCUSSION

LOCS III although is a cost effective but a subjective method that is not ubiquitously used in clinical practice and is subjected to variability secondary to

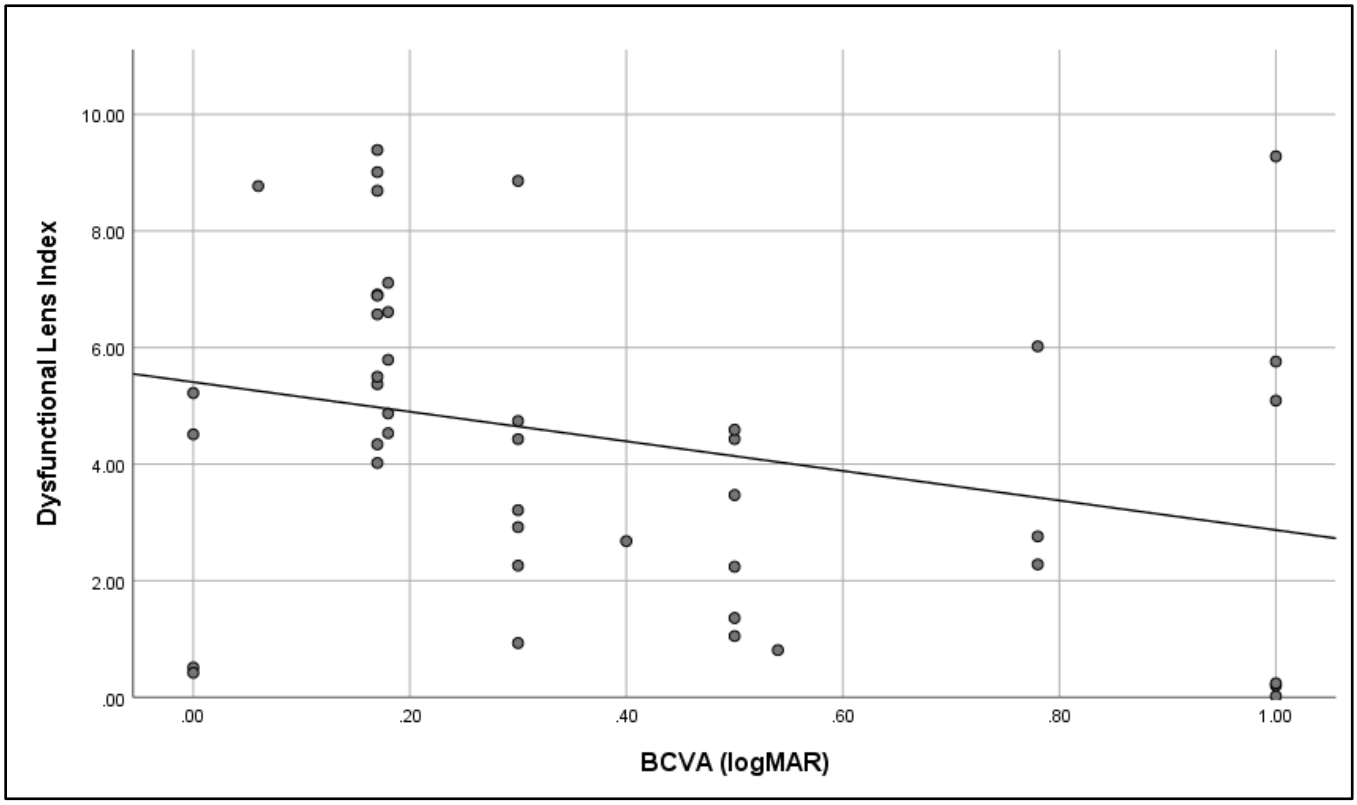

Figure 2(a): Correlation among Best Corrected distance Visual Acuity (logMAR) and Dysfunctional Lens Index.

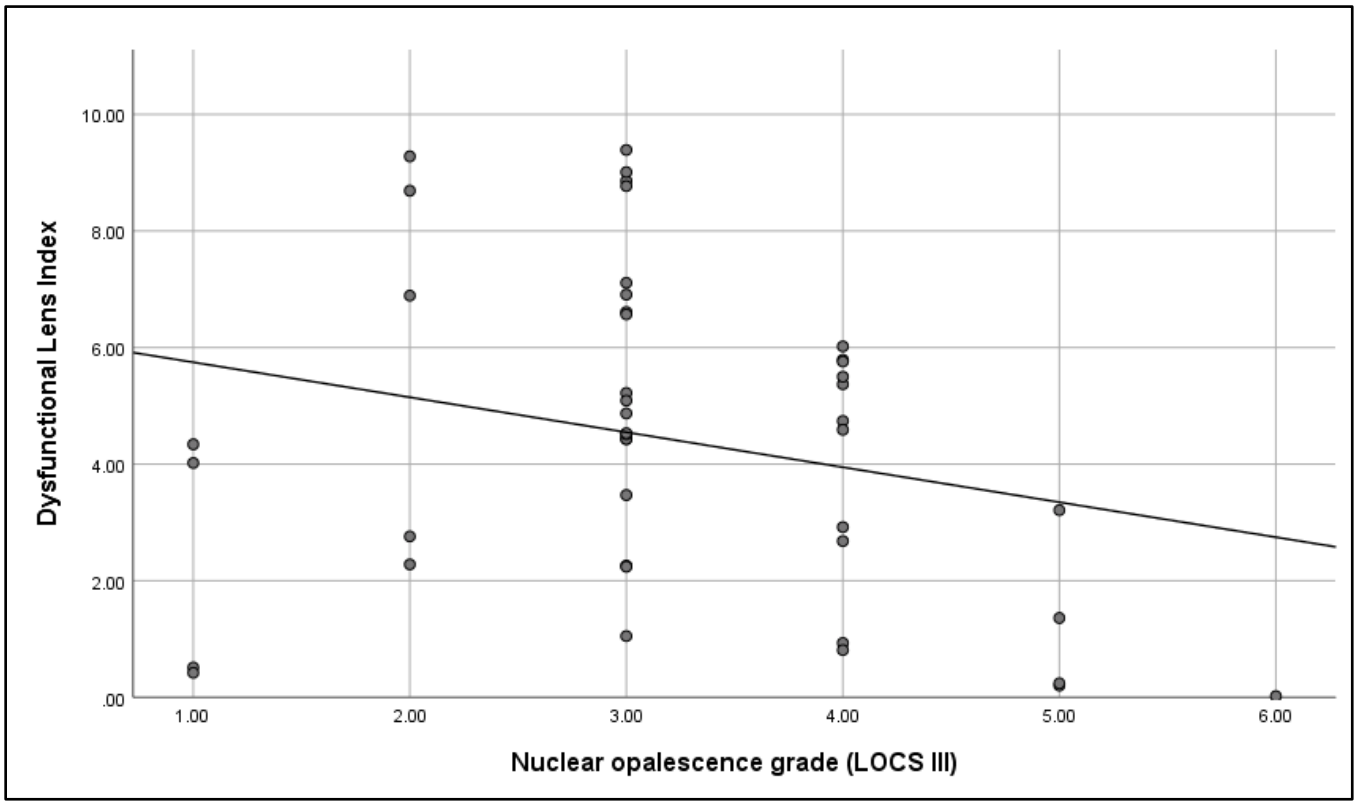

Figure 2(b): Correlation among Dysfunctional Lens Index and Nuclear opalescence grade (LOCS III).

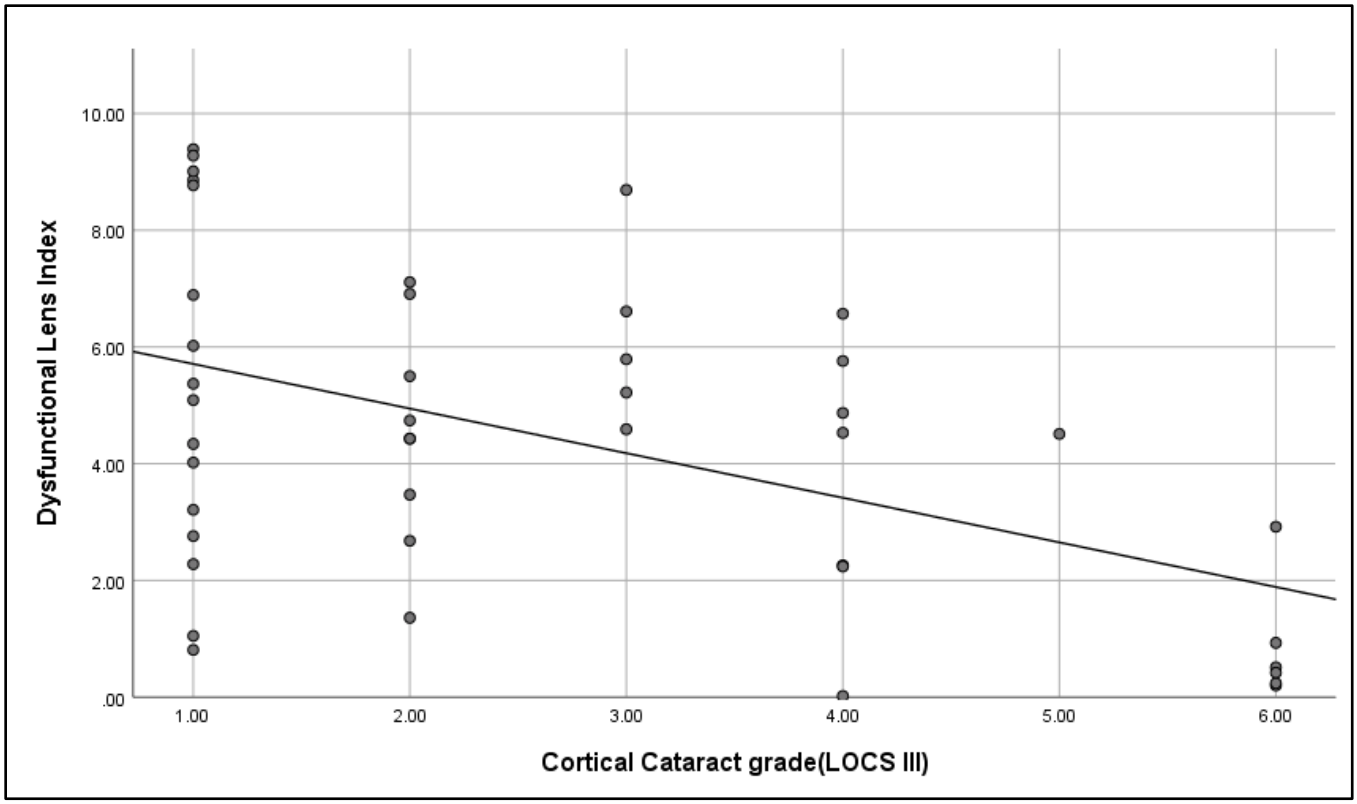

Figure 2(c): Correlation among Dysfunctional Lens Index and Cortical Cataract grade (LOCS III).

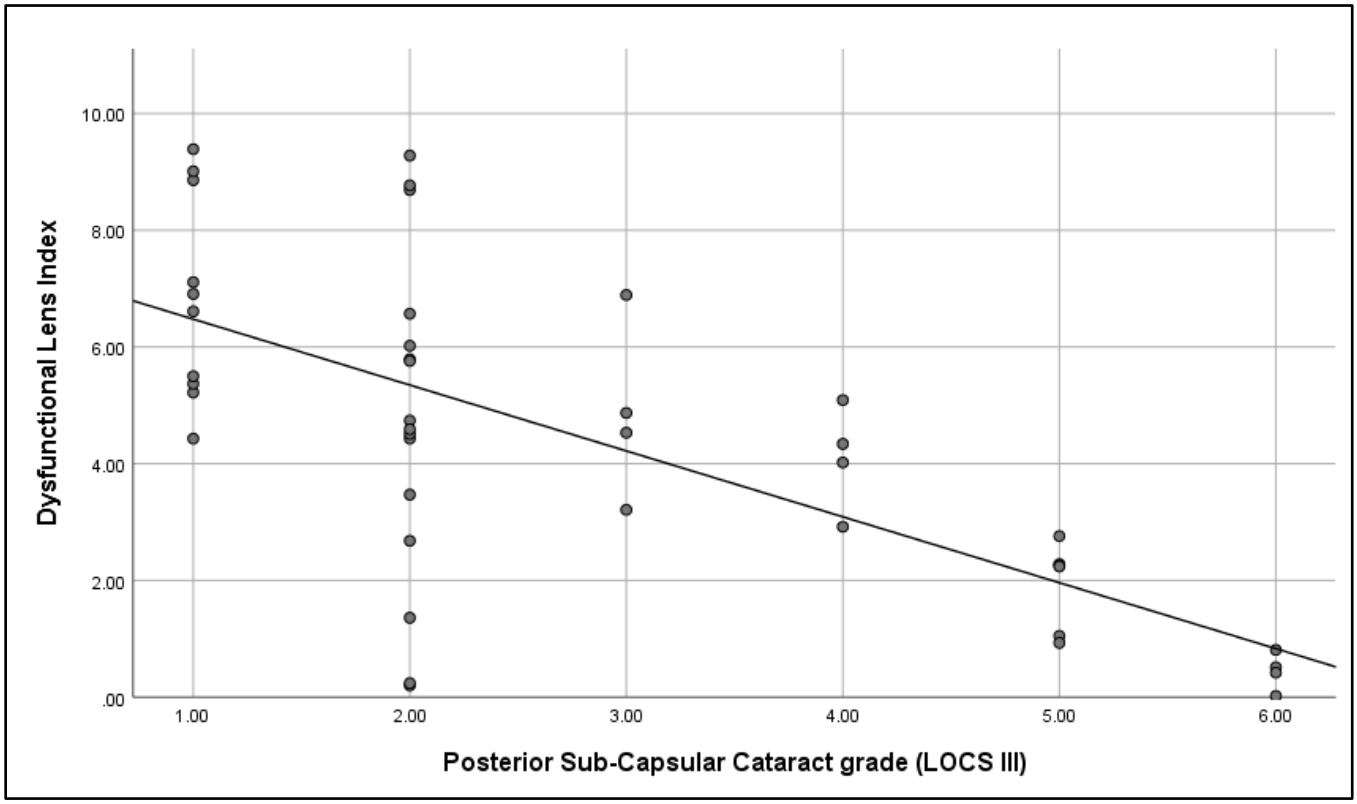

Figure 2(d): Correlation among Dysfunctional Lens Index and Posterior Sub-Capsular Cataract grade (LOCS III).

inter and intra-observer variability.[18-21] Whereas, various conditions like dysfunctional lens syndrome and early cataract can alter quality of vision but do not show on LOCS III.[16] There is a need for objective, reliable and repeatable method to quantify cataract and DLI can be one of the methods as it has the ability to quantify the visual aberrations contributed by lens and distinguish it from the total aberrations of the eye. Many studies have shown that ray tracing aberrometry is a valid method to quantify the visual changes secondary to cataract.[18,22] Our study found that BCVA (logMAR) was significantly and negatively correlated to DLI and BCVA had strongest positive linear correlation with the LOCS III NO score, these findings are consistent with multiple previous researches.[16,20-25]

Previous research has demonstrated that nuclear sclerosis is an aging-related phenomenon that affects both the optical density of the lens and vision quality.[3] A rise in HOAs is present in patients with opacification of the nucleus and cortex.[18] Additionally, Lee et al, showed a rise in HOA using ray-tracing wavefront technique in nuclear cataracts.[5]

It is worth noting that BCVA had insignificant and small to no correlation to LOCS III C score and P score respectively; whereas, DLI showed the strongest significant correlations with LOCS III P score and LOCS III C scores. This suggest that Compared to the LOCS III classification, the DLI is more closely associated with the patient's visual symptoms defined by the optical quality. It further confirms the fact that even though the BCVA is good/satisfactory there are visual disturbances experienced by the patient and BCVA alone cannot be used as a threshold for cataract surgery. Patient's symptoms, visual satisfaction and complete optical examination is helpful for the decision of cataract surgery. DLI as it provides the objective quantification of crystalline lens should become a new standard of practice and can be used as objective, reproducible and non-contact method in conjunction with LOCS III to assess the patients and predict phacodynamics.[20]

Our study observed that DLI had small negative non-significant correlation with LOCS III NO score (r= -0.234, P=.126). However, previous studies reported a much stronger and significant (r= −0.662 and r= −0.728) relationship between NO and DLI.[16,20]Li et al observed that DLI ≤ 5.7 provided a better surgery criterions for age related nuclear cataract surgery as compared to preoperative BCVA.[17]

This was a single center study with a limited sample size, additionally we only accessed one objective method to quantify age related cataract. Study findings cannot be generalized and larger studies evaluating various methods to quantify age related cataract should be conducted to give a new objective gold standard. Currently there is no consensus regarding which approach or variable is the most representative of the lens's actual optical condition.[18] The methodology did not take into account "nucleus colour" evaluation since, according to earlier research, lens density and nuclear opalescence were more strongly correlated.[18,24]

CONCLUSION

It is important to define preoperative characteristics that can effectively predict the visual improvement, both objectively and subjectively, after cataract surgery to ensure that cataract surgery is offered earlier to patients. Our study provides information on lens performance by Wavefront analysis that will prove to be useful in preplanning factors relating to cataract surgery. This will be of great help to surgeon by anticipating subsequent phacoemulsification requirements intra-operatively.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(2201-2220).**

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Nauman Hashmani; Consultant Ophthalmologist: *Concepts, Design, Data acquisition, Manuscript preparation Manuscript review.*

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Aiman Monis; Resident: *Concepts, Design, Data acquisition, Data analysis, Manuscript review.*