Analysis of Visual Function in Patients with Nuclear, Cortical and Posterior Subcapsular Cataracts in Lumbini Eye Institute and Research Center

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ABSTRACT

Background

Cataract is the leading cause of reversible blindness worldwide, affecting visual function through different morphological types. Nuclear sclerosis often reduces distance vision with myopic shift, cortical cataract commonly causes glare and variable acuity, while posterior subcapsular cataract disproportionately impairs best-corrected visual acuity. Evaluating these differences in visual function is important for patient counseling and surgical planning. This study analyzes visual acuity, contrast sensitivity, color vision and glare among patients with nuclear, cortical, and posterior subcapsular cataracts.

Methods

A cross-sectional study was conducted among 395 patients (131 per cataract type) at Lumbini Eye Institute, Nepal. Cataract grade was assessed using LOCS III, and visual function evaluated with Snellen's chart (VA), Ishihara chart (color vision), Pelli-Robson chart (contrast sensitivity), and Glare and Halo Questionnaire.

Results

Among 395 patients (52.2% female), mean logUCVA was worst in nuclear sclerosis (0.94±0.35) and best in cortical cataract (0.76±0.33; p-value<0.001), while logBCVA was poorest in PSCC (0.61±0.31; p-value< 0.001). NS showed myopic, CC hyperopic, and CC had highest astigmatism (p-value=0.008). Contrast sensitivity was highest in CC and lowest in PSCC (p-value=0.015). Glare increased with cataract grade, most frequent in PSCC (92%). Color vision remained normal in >96% of all groups (p-value=0.66).

Conclusions

Visual function varied among cataract types, with nuclear sclerosis showing worse UCVA, posterior subcapsular cataract worse BCVA, cortical cataract higher contrast sensitivity, and glare increasing with cataract grade, while color vision remained largely unaffected.

Keywords: cataract; visual function; visual acuity; contrast sensitivity; color vision.

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INTRODUCTION

Cataract is the leading cause of vision loss worldwide[1], Nuclear cataract form in the central lens, causing myopia[2–6]; cortical cataracts in the outer cortex cause hyperopia[1,7] and variable astigmatism; [3–6] posterior subcapsular cataracts at the back of the lens cause glare, myopia, [1,4] and astigmatism.[3] Glare disability[8], contrast sensitivity, sensitively reflects visual loss, especially in mild to moderate cataracts.[9] In 2022, cataracts caused 17 million cases of blindness (39.6% globally) and 83.5 million cases of moderate-to-severe vision impairment (28.3%).[2] In Nepal, blindness in those ≥50 declined from 2.5% in 2010 to 1.05% in 2021, with cataract still the leading cause.[10] Factors include cataract type[2,6,11] and grade[3,4], refractive errors[2–4,6,11], and visual function[7] measures such as acuity[5,12], contrast sensitivity[5,12,13], and glare.[5,13] Few studies compare visual function across cataract types; our larger sample allows a robust assessment. This study aims to analyze visual function in nuclear, cortical, and posterior subcapsular cataracts.

METHODS

The hospital-based cross-sectional study was conducted at the General Outpatient Department of Lumbini Eye Institute and Research Center (LEIRC), Bhairahawa, Nepal, which was chosen due to its large and diverse patient population and role as a leading tertiary eye care center. The study was carried out over a period of May 2024 to September 2025. The study population consists of patients aged between 16–60 years, diagnosed with nuclear, cortical, or posterior subcapsular cataract. Purposive sampling technique was used and sample size was calculated using finite population visiting LEIRC (N=26634 presenting with cataract between May 2023 to May 2024) with 5% margin of error, the sample size was 395, 131 participants in each subgroup. Patients of 16–60 years aged group with nuclear, cortical, or posterior subcapsular cataract were included while prior ocular surgery, mixed type of cataract, coexisting ocular pathologies, ocular trauma or surgery, systemic diseases affecting vision such as diabetes, and inability to perform visual tests were excluded. Ethical approval was obtained from the institutional review committee with approval no: 54/024/25., and informed consent was taken from all participants. Data collection tools include demographic and clinical history forms, Snellen chart for UCVA and BCVA, slit lamp biomicroscope for cataract grading using LOCS III, 90D Volk lens for posterior segment evaluation, Pelli–Robson chart for contrast sensitivity, and Glare and Halo Questionnaire for subjective symptoms. Data was entered in SPSS version 16, analyzed using analytical statistics, and inferential tests such as chi-square (Glare and colour vision) and ANOVA (logUCVA, logBCVA, refractive error, contrast sensitivity) was used to assess the relationship between cataract type/severity and visual function outcomes.

RESULTS

Among the 395 patients, 206(52.2%) were female and 189(47.8%) were male, showing a nearly equal gender distribution. Cataract involvement was also almost symmetrical between eyes, affecting 205 right eyes (51.9%) and 190 left eyes (48.1%). According to LOCS III, most eyes were grade 2(156) or grade 3(165), with fewer eyes in grade 1(38) and grade 4(36) (Figure 1).

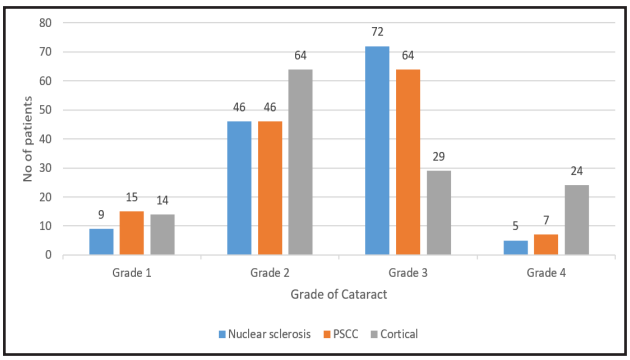

Figure 1. Distribution of cataract types by grade (LOCS III) among study participants.

For UCVA, mean logUCVA differed by cataract type: cortical 0.76±0.33, PSCC 0.88±0.35, nuclear sclerosis 0.94±0.35. The overall effect of cataract type on UCVA was not statistically significant (ANOVA: F=2.345, p-value=0.097), but pairwise comparisons showed cortical cataracts had significantly better UCVA than nuclear sclerosis

(p-value<0.001) and PSCC (p-value=0.001). UCVA worsened progressively with cataract grade (p-value< 0.001), from grade 1 (0.44±0.35) to grade 4 (1.19±0.24), and the type with grade interaction was significant (p-value=0.009), with PSCC causing worse vision in advanced grades (Table 1). For BCVA, mean logBCVA differed by cataract type: cortical 0.40±0.28, nuclear sclerosis 0.48±0.29, PSCC 0.61±0.31 (F=13.562, p-value<0.001). BCVA also worsened with increasing grade (F=127.998, p-value<0.001), from grade 1 (0.14±0.20) to grade 4 (0.87±0.12), with a significant type with grade interaction (p-value=0.011) (Table 1).

The mean refractive parameters differed significantly among the three types of cataracts (ANOVA, p-value<0.001). Patients with nuclear sclerosis had a mean spherical power of –1.25±2.18 D, cylindrical power of –0.56±1.04 D, and a mean cylinder axis of 44.3°±58.2°. In posterior subcapsular cataract, the mean spherical power was –0.29±1.56 D, cylindrical power –0.62±1.03 D, and cylinder axis 51.0°±58.9°. In contrast, cortical cataract cases showed a mean spherical power of +1.24±2.26 D, cylindrical power –0.90±0.79 D, and cylinder axis 82.0°±53.5° (Table 2).

Contrast sensitivity decreased progressively with increasing cataract grade across all types (p-value< 0.001). Posterior subcapsular cataracts showed the lowest contrast sensitivity, particularly at higher grades, while nuclear sclerosis and cortical cataracts had slightly higher values (Table 3). Cataract type alone was not statistically significant (p-value=0.056), and the interaction between type and grade was borderline (p-value=0.057). These findings indicate that cataract severity is the main determinant of reduced contrast sensitivity.

Table 3. Contrast sensitivity among different types of cataract.

Cataract Type	Contrast Sensitivity (Mean ± SD)
Nuclear sclerosis	1.34 ± 0.18
Posterior subcapsular	1.30 ± 0.21
Cortical cataract	1.37 ± 0.21

Most patients had normal colour vision across all cataract types (nuclear sclerosis: 128/132, posterior subcapsular: 130/132, cortical: 127/131), and cataract type was not significantly associated with colour vision (χ^2 =0.83, p-value=0.66). However, abnormal colour vision increased with higher cataract grades, particularly in Grades 3 and 4 (Grade 3: 4/165;

Table 1. Mean logUCVA and logBCVA by Cataract Type and Grade (logMAR, Mean ± SD).

Cataract Type	Grade 1	Grade 2	Grade 3	Grade 4	Total
Nuclear sclerosis	UCVA: 0.62 ± 0.55 BCVA: 0.20 ± 0.32	0.74 ± 0.27 0.29 ± 0.20	1.11 ± 0.26 0.61 ± 0.23	0.996 ± 0.31 0.83 ± 0.17	0.94 ± 0.35 0.48 ± 0.29
PSCC	0.35 ± 0.21	0.72 ± 0.26	1.08 ± 0.23	1.26 ± 0.23	0.88 ± 0.35
	0.14 ± 0.18	0.44 ± 0.23	0.80 ± 0.19	0.97 ± 0.08	0.61 ± 0.31
Cortical	0.43 ± 0.28	0.61 ± 0.20	0.88 ± 0.24	1.21 ± 0.21	0.76 ± 0.33
	0.10 ± 0.09	0.26 ± 0.14	0.49 ± 0.19	0.85 ± 0.11	0.40 ± 0.28
Overall Mean	0.44 ± 0.35	0.68 ± 0.25	1.05 ± 0.26	1.19 ± 0.24	0.86 ± 0.35
	0.14 ± 0.20	0.32 ± 0.20	0.66 ± 0.24	0.87 ± 0.12	0.50 ± 0.31

Table 2. Comparison of refractive parameters (spherical power, cylindrical power, and cylinder axis) among different types of cataracts.

Cataract Type	Spherical Power (Mean ± SD)	Cylindrical Power (Mean ± SD)	Cylinder Axis (Mean ± SD)
Nuclear sclerosis	–1.25 ± 2.18	–0.56 ± 1.04	44.3 ± 58.2
Posterior subcapsular	–0.29 ± 1.56	–0.62 ± 1.03	51.0 ± 58.9
Cortical cataract	+1.24 ± 2.26	–0.90 ± 0.79	82.0 ± 53.5

Table 4. Patient-reported glare and bright light sensitivity by cataract type.

Cataract Type	Discomfort due to Glare (Yes/No)	Glare Severity (Strong/Moderate/ Mild/Not at all)	Sensitive to Bright Light (Yes/No)	Bright Light Sensitivity (Very/Moderate/Mild/ Not at all)
Nuclear Sclerosis	100 / 32	16 / 34 / 55 / 27	112 / 20	23 / 41 / 51 / 17
Posterior Subcapsular	121 / 11	34 / 45 / 46 / 7	122 / 10	38 / 47 / 39 / 6
Cortical Cataract	91 / 40	7 / 49 / 40 / 35	98 / 33	19 / 36 / 45 / 31

Grade 4: 5/36), and this association was statistically significant (χ^2=22.07, p-value<0.001). These findings suggest that cataract severity, rather than type, influences colour vision abnormalities.

Discomfort due to glare was reported by most patients, particularly in posterior subcapsular (121/132) and nuclear sclerosis (100/132) cataracts, while cortical cataracts had slightly fewer reports (91/131). Strong glare was most common in PSC, whereas mild glare predominated in NS and cortical cataracts. Sensitivity to bright light was highest in PSC (122/132), followed by NS (112/132) and cortical cataracts (98/131). Very high sensitivity to bright light was more frequent in PSC (38), while moderate and mild sensitivity were more common in NS and cortical cataracts (Table 4). Overall, PSC cataracts w ere associated with more severe glare and light sensitivity, whereas cortical cataracts were associated with milder symptoms.

DISCUSSION

This study assessed the impact of different types and grade of cataract on visual function. In this study of 395 patients with cataract, the demographic distribution was nearly equal by sex and eye laterality, which is consistent with Journal of Gorgan University of Medical Sciences[12] , where a balanced gender and laterality distribution was also observed. However, our study included a larger sample size, thereby providing a stronger representation of the population. The predominance of moderate grades (LOCS III grade 2 and 3) in our series parallels with the study conducted by Shandiz et al[5] in which most cataracts were clustered in intermediate severity, reflecting the typical stage at which patients seek surgical evaluation.

This study findings on visual acuity highlight the functional impact of cataract type and grade. Mean UCVA was worst in nuclear sclerosis and best in cortical cataracts, while PSC cataracts showed intermediate values but progressed to severe vision loss in advanced grades. This pattern is aligned with beaver dam eye study[14] and study conducted by Williamson et al,[13] both of which demonstrated that cortical cataracts retain relatively better UCVA compared with nuclear sclerosis and PSC. The progressive worsening of both UCVA and BCVA with advancing grade in our study echoes with other studies,[5,13] further confirming that cataract severity rather than type alone drives vision decline. Importantly, our result also showed a significant interaction of type with grade, where PSC cataracts disproportionately impaired vision in higher grades, a finding with Mahjoob[12] and Elzarrug et al.[2] With respect to refractive parameters, our study demonstrated a clear distinction between cataract types: nuclear sclerosis was associated with a myopic shift, cortical cataracts with a hyperopic trend, and PSC with minimal spherical change. Nuclear sclerosis and PSCC grades did not significantly affect the type of astigmatism, whereas cortical cataracts demonstrated a strong association, with higher grades shifting astigmatism from with the rule toward Against The Rule and oblique. These findings agree with Pesudovs and Elliott[11] and Ajenjo et al.[3] that cortical cataracts have the greatest impact on astigmatic changes.

Contrast sensitivity decreased progressively with increasing cataract grade, with PSCC showing the lowest values, while nuclear sclerosis and cortical cataracts had slightly higher levels. Cataract severity, rather than type, was the main determinant of reduced contrast sensitivity. As stated by Shandiz et al.[5] and

Gupta et al.[15] Williamson in 1992 also reported greater contrast loss in PSCC and cortical cataracts, especially under glare conditions.[13] Color vision in our study was largely preserved across cataract types, but worsened significantly with increasing cataract grade, with the highest abnormalities observed in Grade 4 which is consistent with previous Trivector studies, showing that cataract severity, particularly in nuclear sclerosis, reduces color vision sensitivity, whereas type alone has minimal effect.[16]

Most patients reported glare and bright light sensitivity, with posterior subcapsular cataracts showing the highest severity, followed by nuclear sclerosis and cortical cataracts. Strong glare and very high light sensitivity were most frequent in PSCC, consistent with Lasa et al.[17] and Pelli-Robson glare studies[13] showing PSCC significantly reduces contrast sensitivity under glare. These results highlight the importance of assessing glare disability in addition to visual acuity in cataract patients.

Cataract severity, more than type, determines visual function. Assessment should include contrast sensitivity, color vision, and glare testing which are the factors that significantly affect daily activities. Limitations include subjective measures of glare and bright light sensitivity and smaller subgroup sizes especially in Grade 4 PSCC which may affect precision. Objective instruments like Brightness Acuity Tester (BAT) and high- glare contrast sensitivity devices provide quantitative measurements overcoming the limitation of subjective questionaries. The cross-sectional design also limits evaluation of progression. Future studies in Nepal should incorporate longitudinal assessments and explore interventions to reduce glare and contrast sensitivity loss, particularly in posterior subcapsular and cortical cataracts, to improve functional vision and quality of life.

CONCLUSIONS

Cataract severity, more than type, determines visual impairment, affecting visual acuity, contrast sensitivity, color vision, and glare. Posterior subcapsular cataracts caused the most pronounced glare and contrast loss, while cortical cataracts influenced astigmatic changes. Comprehensive assessment including contrast, color vision, and glare testing is essential. Future longitudinal studies with objective glare measurements are recommended to optimize patient care and functional outcomes.

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