

Assessment Of Cataract Morphology And Visual Outcomes After Surgery Nuclear, Cortical, Posterior Subcapsular Cataract.

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ABSTRACT

Background: Cataract remains a leading cause of preventable blindness worldwide. With respect to visual acuity, the complexity, the surgery, and the postoperative outcomes, the various forms of cataracts, i.e., nuclear, cortical, and posterior subcapsular, may cause variations. It is essential to address differences in postoperative recovery for each type of cataract extraction. This would aid in selecting the right patients, providing appropriate pre-surgery counseling, and managing reasonable expectations during postoperative recovery in a low-resource environment.

Objectives: To identify the various cataract morphologies and to evaluate differences in visual outcomes before and after cataract extraction with intraocular lens implantation.

Methodology: A cross-sectional study was conducted on 120 patients aged 40 years who underwent cataract extraction. The type of cataract was classified using slit lamp biomicroscopy. Visual acuity was measured with a Snellen chart before and after the surgery. All patients had phacoemulsification or extracapsular extractions and had a posterior chamber intraocular lens implanted. The data were analyzed using SPSS v24.0, and paired t-tests and ANOVA were used to assess vision improvement across groups. A p-value < 0.05 was statistically significant. Patients with retinal disease, glaucoma, a corneal opacity, or those who had had previous intraocular surgery were excluded.

Results: 120 patients (mean age 63.4 ± 8.2 years), nuclear cataract was most common (45%), followed by cortical (32%) and posterior subcapsular cataract (23%). PSC patients had the poorest preoperative visual acuity, with 78% below 6/60. Postoperatively, all groups showed significant improvement (p < 0.001). PSC patients demonstrated the greatest gain, with 82% achieving ≥6/12 vision at six weeks. Nuclear and cortical cataracts achieved ≥6/12 in 76% and 70% of cases, respectively. ANOVA confirmed a statistically significant difference in mean improvement across morphologies (p = 0.03). Minor postoperative edema occurred in 8% and resolved conservatively.

Conclusion: The morphology of the cataracts affects how much baseline functionality is lost and how much functionality is regained after surgery, and PSC cataracts show the most significant improvement after surgery. PSC cataracts affect vision more than other types; therefore, cataract surgeries are more effective for PSC cataracts.

Keywords: Cataract morphology, Visual outcomes, Phacoemulsification, Posterior subcapsular

1. INTRODUCTION

Cataracts are the leading cause of reversible blindness globally and impact millions of people, especially those in low and middle-income regions of the world who are unable to obtain the necessary surgical treatment promptly [1]. Age-related cataract is a slowly progressive condition characterized by the gradual opacification of the crystalline lens, leading to visual dysfunction severe enough to compromise one's ability to perform daily living activities autonomously and to reduce one's quality of life. Surgical treatment is cost-effective and the most successful treatment option; however, multiple clinical and morphological parameters influence the visual prognosis [2]. Cataract morphology is one of the parameters and can be classified as nuclear sclerosis, cortical cataract, and posterior subcapsular cataract (PSC). This morphology is the most critical factor in determining preoperative visual acuity, the complexity of the surgery, and postoperative recovery [3]. Nuclear cataracts are the most common and typically result from age-related compaction and yellowing of the lens nucleus. This condition is often associated with a progressive decline in distance vision and the development of myopia, which may be accompanied, at first, by improvement in near vision. Eventually, however, there is a rapid decline of vision as nuclear sclerosis progresses [4]. Cortical cataracts occur as a consequence of the degeneration of lens fibers and are characterized by spoke-like opacities that can disturb the passage of light. People with this condition often describe visual disturbances, especially in bright light, including glare, halos, and monocular diplopia [5]. On the other hand, posterior subcapsular cataracts, while small, tend to cause far more significant visual symptoms in the visually impaired because they are situated centrally. Patients with PSC frequently exhibit profound loss of near vision, debilitating glare, and light sensitivity [6]. Determining the types of cataracts and their distributions is fundamental to the fabric of contemporary cataract surgery. Different types of cataracts may require varying levels of surgical dexterity and diligence. For example, dense nuclear cataracts may require more energy during phacoemulsification, increasing the risk of corneal endothelial damage or an inflammatory reaction. PSCs are situated more anteriorly than the posterior capsule and may carry a small risk of greater motility-related intraoperative complications in advanced cataracts [7]. Cortical cataracts, despite being visually disturbing in some morphologies, are less likely to pose surgical dilemmas, but may have intractable pupil dilatation—reference 6. Vision, or the lack of it, still affects surgery and remains a significant concern for patients. Studies have shown that patients with PSC experience rapid visual improvement after surgery, reflecting the significant visual disability they experienced before surgery [8]. Vision improvement after surgery is also observed with nuclear cataracts; in other cortical cataracts, the post-surgical visual prognosis is much more variable and less favorable when significant astigmatism is also present, with variable spoke patterns within the cortical cataract. The evaluation of visual function improvement based on cataract morphology helps set realistic expectations, inform patients, and determine the surgical order of cases based on anticipated surgical benefit and the severity of the cataract [9]. While cataracts are highly prevalent in low-income countries, there remains a paucity of local data comparing outcomes by morphology after cataract surgery. In many areas, variability in surgical skill, technology, and patient accessibility significantly impacts the success of surgery and postoperative outcomes. Thus, evaluating visual outcomes across different cataract types sheds light on the clinical effectiveness of the case and on areas of surgical planning efficiency and resource utilization.

Research Objectives:

Assessing the disposition of the nuclear, cortical, and posterior subcapsular cataracts and their pre- and post-surgical visual outcomes after the removal of cataract and intraocular lens placement.

2. MATERIALS AND METHODS:

Study Design & Setting:

This Cross Sectional Study conducted at department of Ophthalmology, Gajju Khan Medical College Swabi from July to Dec 2024.

Participants:

Patients aged 40 years or older with an operable cataract diagnosis and scheduled for phaco or extracapsular extraction were included in the sample. Preoperative assessments included slit-lamp examination, visual acuity measurement, and cataract classification. Patients were excluded if they had retinal conditions, glaucoma, an opaque cornea, or prior intraocular surgery. Only those who completed postoperative follow-up were included in the final analysis.

Sample Size Calculation:

With 90% of patients expected to have improved vision postoperatively, a 95% confidence interval, and a 10% margin of error, the minimum necessary sample size was 92 patients. To increase the analysis's ability to account for potential patient loss to follow-up, 120 patients were included in the sample.

Inclusion Criteria:

Forty years of age, diagnosed with nuclear, cortical, or PSC cataract, and planned cataract extraction with posterior chamber IOL. Patient signed informed consent forms.

Exclusion Criteria:

Cataract complications due to diabetes, Retinal vascular issues or degeneration, macular degeneration, Advanced or chronic glaucoma, History of intraocular surgical procedures, Traumatic or congenital cataract

Diagnostic & Management Strategy:

Cataract complications due to diabetes, Retinal vascular issues or degeneration, macular degeneration, Advanced or chronic glaucoma, History of intraocular surgical procedures, Traumatic or congenital cataract

Statistical Analysis:

Data were analyzed with SPSS version 24. Descriptive statistics provided frequencies and percentages for categorical variables and means and standard deviations for continuous variables. To assess differences in visual acuity before and after surgery, paired t-tests were used. For different cataract types, ANOVA was used to compare visual improvements. A p-value of less than 0.05 was considered significant.

Results:

A total of 120 patients were included, with a mean age of 63.4 ± 8.2 years. Nuclear cataract was the most common type (45%), followed by cortical (32%) and posterior subcapsular cataract (23%). Preoperatively, PSC patients demonstrated the poorest visual acuity, with 78% having VA $<6/60$, whereas cortical cataract patients showed comparatively better baseline vision. Nuclear cataract patients presented with moderate impairment. Postoperative assessments revealed marked improvement in visual acuity across all cataract types ($p < 0.001$). PSC patients achieved the greatest visual gain, with 82% attaining VA $\geq 6/12$ at six weeks. Nuclear cataract patients achieved VA $\geq 6/12$ in 76% of cases, while cortical cataract patients reached this level in 70% of cases. ANOVA demonstrated a statistically significant difference in mean postoperative improvement among the three groups ($p = 0.03$), with PSC showing the highest gains. Minor postoperative corneal edema occurred in 8% of patients and resolved with medical therapy. No major complications were reported. Overall, the surgery resulted in strong visual rehabilitation irrespective of cataract morphology.

Intervention Outcome:

Implantation of posterior chamber IOLs significantly improved vision in all cataract cases. Patients with PSC had the most remarkable recoveries as a result of the preoperative visual deficits they experienced. The surgery was highly effective and safe, with a minimal incidence of post-surgery complications and a high rate of postoperative vision improvement.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n = 120)

Variable	Nuclear Cataract (n = 54)	Cortical Cataract (n = 38)	PSC Cataract (n = 28)	Total (n = 120)
Mean age (years) \pm SD	64.1 \pm 7.9	62.8 \pm 8.4	63.6 \pm 8.7	63.4 \pm 8.2
Gender (Male)	29 (53.7%)	21 (55.3%)	14 (50.0%)	64 (53.3%)
Gender (Female)	25 (46.3%)	17 (44.7%)	14 (50.0%)	56 (46.7%)
Hypertension	24 (44.4%)	14 (36.8%)	10 (35.7%)	48 (40.0%)
Diabetes mellitus	18 (33.3%)	11 (28.9%)	9 (32.1%)	38 (31.7%)

Table 1 presents the baseline demographic and clinical characteristics of the study participants stratified by cataract morphology. Nuclear cataract was most common. Age, gender, and comorbidities were comparable across groups, with no statistically significant differences.

Table 2: Preoperative Visual Acuity by Cataract Morphology

Preoperative VA Category	Nuclear (n = 54)	Cortical (n = 38)	PSC (n = 28)	p-value
$\geq 6/18$	6 (11.1%)	9 (23.7%)	2 (7.1%)	—
6/24–6/60	33 (61.1%)	23 (60.5%)	4 (14.3%)	—
$<6/60$	15 (27.8%)	6 (15.8%)	22 (78.6%)	<0.001

Table 2 shows preoperative visual acuity distribution. PSC patients had the poorest presenting visual acuity, with 78.6%

below 6/60. Differences between groups were statistically significant ($p < 0.001$).

Table 3: Postoperative Visual Acuity at Six Weeks

Postoperative VA	Nuclear (n = 54)	Cortical (n = 38)	PSC (n = 28)	p-value
≥6/12	41 (75.9%)	27 (71.1%)	23 (82.1%)	—
6/18–6/36	11 (20.4%)	8 (21.1%)	4 (14.3%)	—
<6/60	2 (3.7%)	3 (7.9%)	1 (3.6%)	0.03

Table 3 summarizes postoperative visual acuity at six weeks. All groups demonstrated substantial visual improvement. PSC cataract patients showed the highest level of recovery, with 82% achieving visual acuity ≥6/12.

Table 4: Comparison of Mean Visual Improvement Across Cataract Types

Cataract Type	Mean Pre-op VA (Logar) ± SD	Mean Post-op VA (Logar) ± SD	Mean Improvement	p-value (ANOVA)
Nuclear	0.82 ± 0.21	0.23 ± 0.15	0.59	—
Cortical	0.78 ± 0.19	0.28 ± 0.17	0.50	—
PSC	1.10 ± 0.25	0.20 ± 0.14	0.90	0.03

Table 4 compares pre- and postoperative visual acuity using Logar values. PSC patients demonstrated the greatest mean improvement (0.90), followed by nuclear and cortical cataracts. ANOVA showed statistically significant differences among morphology groups ($p = 0.03$).

3. DISCUSSION:

The objective of this study was to assess the degree of morphology of each type of cataract, specifically nuclear, cortical, and posterior subcapsular, and to analyze the differences in visual prognosis following cataract surgery and intraocular lens implantation. Evidence showed that all types of cataracts demonstrated remarkable visual improvement following surgery, but patients with posterior subcapsular cataracts (PSC) gained the best visual prognosis. Such findings are expected, as PSCs are known to have worse visual prognosis before surgery due to their location along the visual axis [10]. In this study, as in most of the world, the nuclear type was the most prevalent, a finding supported by similar studies over the last five years, indicating nuclear sclerosis cataracts as the most common type of cataract related to aging and in older patients [11]. This is because cataract development results from biochemical changes associated with aging, including lens fiber consolidation and increased oxidative stress. Evidence shows that PSC patients had the least amount of preoperative visual acuity, similar to the most recent research conducted in South Asia and Africa that states that 70-85% of PSC patients have baseline visual acuity that is 6/60 or worse before surgery PSC is characterized by a greater inability to see both near and far in the distance, even in the early stages, because of the central opacification. This finding indicates that PSC patients had the most significant improvement after surgery in our study, because removal of the opacity allowed the central visual axis to function fully. As for visual outcomes, this study shows that all groups had excellent visual function, with 76% of nuclear, 70% of cortical, and 82% of PSC patients achieving 6/12 visual acuity or better at 6 weeks after surgery. These results correlate with those reported by Rahman et al. [12,13] (2021), who found a likelihood of 6/12 clarity postoperatively in 72–85% of patients, regardless of morphology [14]. A similar report from a 2020 multicenter study found that cataract morphology did not limit recovery postoperatively when seasoned surgeons performed phacoemulsification. However, some studies have reported slightly worse outcomes associated with dense nuclear sclerosis, where the required phase energy was higher and where there was an associated loss of endothelial cells [15,16]. This study also reported overwhelmingly favorable outcomes among patients with nuclear cataracts, which is likely due to the retention of standard surgical protocols and diligent intraoperative management, particularly for atomic cataracts. ANOVA analysis indicates that there were significant differences in average postoperative vision improvement among the different types of cataracts. PSC cataracts, as noted in other recent studies, showed the most tremendous improvement [17]. The most significant variability, consistent with other studies, was observed in patients with cortical cataracts, where cortical spokes and irregular astigmatism have been reported to influence both preoperative visual acuity and postoperative refractive stability [18]. A particularly noteworthy observation in this study was the minimal complication rate, with the only reported complication being mild, transient corneal edema. Recent global evaluations have reported declining complication rates as phacoemulsification techniques and intraocular lens designs continue to improve.

4. LIMITATIONS:

This study is limited by its single-center design and relatively short postoperative follow-up periods, which may fail to capture long-term visual sequelae. Advanced imaging, such as OCT, was not performed to detect subtle macular pathology. Further, the surgical outcome may vary according to the surgeon's level of experience, which was not classified in this study.

5. CONCLUSION:

Cataracts have varying forms that affect preoperative visual acuity without restricting postoperative vision-related recovery, as all forms result in acceptable, adequate post-surgical vision. Patients with posterior subcapsular cataracts achieved the most significant improvement in vision after surgery. Morphologic evaluation serves an essential purpose in surgical planning, patient information and counseling, and refining case order, thereby optimizing the positive outcomes, safety, and effectiveness of cataract surgery with intraocular lens exchange.

Disclaimer: Nil

Conflict of Interest: Nil

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Final Approval of version: All Mentioned Authors Approved the Final Version..

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