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Decision-Making Factors Influencing Surgical Management and Visual Outcomes in Uveitic Cataracts: A Prospective Observational Study

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Abstract
Uveitic cataracts are a major cause of vision loss in patients with chronic intraocular inflammatory disease. Surgical intervention of these cataracts is difficult as a result of the difficulties of persistent inflammation, timing of surgery and perioperative management. The purpose of this study is to assess the clinical and surgical determinants of postoperative visual results and complications in patients treated for cataracts associated with uveitis. The study was a Prospective observational case series of 123 uveitic cataract patients conducted at Department of Ophthalmology of Era's Lucknow Medical College and Hospitals. Demographic and all the clinical and inflammation status data were collected. Details of the time of surgery, the technique employed, type of IOL used and the pre and postoperative steroid regimens were recorded. The patients were followed for 3 months after surgery in order to evaluate the visual acuity improvement and the rates of complications. Statistical analysis incorporated univariate and multivariate logistic regression for the estimation of the risk of visual improvement. The average age of patients was 42.5±14.3 years and anterior uveitis was the most frequent type (50.4%). Surgery was indicated in 66.7% of patients after minimum of 3 months of quiescence. The operative technique was phacoemulsification with foldable acrylic IOLs. At 3 months, 71.5% in the treatment groups gained 2 Snellen lines in ETDRS visual acuity. Independently, delayed surgery after adequate inflammation was a predictor of better vision (OR 2.8., 95% CI: 1.2-6.5., p = 0.015). The main postoperative complications were cystoid macular edema in 14.6% of eyes and increased intraocular pressure in 12.2%. Modifying the timing of cataract surgery according to inflammatory quiescence markedly improves the visual prognosis in patients with uveitic cataract. Phacoemulsification using foldable acrylic IOLs plus personalized perioperative steroid therapy is safe and effective. Individualised surgical planning based on the inflammatory status is important to achieve optimal functional recovery and to avoid complications.

INTRODUCTION

Uveitis is inflammation of the uveal tract of the eye (including the iris, ciliary body and choroid). Vitelliform macular dystrophy (VMD) represents a common cause of global visual impairment and is estimated to be responsible for 5-10% of the blindness in developed nations and an even greater percentage in undeveloped countries (Wright *et al.,* 1996). Uveitis can be divided according to involved anatomical location and classified as anterior, intermediate, posterior and panuveitis, each with unique clinical features and complications. Uveitis Chronic and/or recurrent uveitis is frequently associated to the cataract formation, one of the commonest and visual damaging sequela. Uveitic cataracts are a special challenge in our field of ophthalmology, as their pathogenesis and its therapeutic options are rather complex. Unlike senile cataracts, which are commonly seen in the elderly as an age-related phenomenon, uveitic cataracts tend to occur in younger patients and may be associated with variable inflammatory activity as well as steroid exposure. In addition, the chronic inflammation and its treatment induce the biochemical and molecular changes in the lens, thereby leading cataract to occur earlier and advance more quickly. As a result, patients with uveitic cataracts suffer from double visual handicap due to both the inflammation disease and the lens opacity[1]. The surgical extraction is still the only way to recover the vision damage caused by cataracts. Yet there are some difficulties in the performance of cataract surgery in eyes with uveitis, which is much more challenging than those with routine procedure. The presence of previous inflammatory status, enhances the intraoperative and postoperative complication rates that include formation of synechiae, CME, hypotony, secondary glaucoma and posterior capsule opacification. Additionally, the ocular tissue in uveitic individuals have a greater fragility and there may be an exuberant inflammatory response to the surgical trauma that causes unpredictable results. These challenges require a detailed preoperative planning and an astute perioperative management to maximize visual rehabilitation[2]. Timeliness of surgery for uveitic cataracts: One of the crucial surgical decisions to be taken in uveitic cataracts is the timing of surgery. A period of quiescence or inactivity of inflammation is strongly advocated as a prerequisite for surgery, generally a minimum of 3 months. This is a waiting period to involute active inflammation, stabilize the ocular milieu and maximize medical therapy. However, such a medical delay needs to be compared with the potential for sustained visual morbidity and patient lifestyle. Making a determination as to whether inflammation is under control to proceed safely relies of clinical judgment as well as objective evaluation tools, such as grading of inflammation scales and imaging modalities (e.g. Optical Coherence Tomography [OCT]). The selection of type of surgery is also crucial. Phacoemulsification, a contemporary cataract removal technique, uses the energy of ultrasound to emulsify the lens and is the preferred technique in many centers because it requires only a small incision, provides fast recovery and induces minimal inflammation. However, MSICS still remains a commonly practiced technique, especially in low-resource settings or with denser cataract[3]. The choice of their surgical approach depends on multiple factors such as cataract density, experience of the surgeon and anatomical or inflammatory problems in the patient. The material and design of IOL are also crucial. Foldable acrylic lenses are preferred because of their biocompatibility and lower potential for aggravating inflammation; however, rigid PMMA lenses can also be used in selected situations. Medical care pre- and postoperatively is essential to the success of cataract surgery in uveitic eyes. Corticosteroids remain the cornerstone of antiinflammatory therapy and may be given systemically, periocularly, or topically depending on the severity of the disease. Immunosuppressants also may be combined in treatment resistant cases if alternate lines of therapy fail to provide satisfactory quiescent stage. Perioperative steroid protocols remain inconsistent with need for personalized dosing to prevent postoperative flares based on disease activity and patient tolerance. Their propitious application lessens and prevents the occurrence of postoperative complications including CME and spikes in IOP[4]. Despite progress in both surgical and medical therapies, the visual results of cataract surgery in uveitis patients continue to be diverse. It has been mentioned in the studies that a substantial number of patients achieve a good visual recovery, but some have been observed with poor outcomes either because of persisting or recurring inflammation or complications due to surgery. Post-operative cystoid macular edema (CME) is still the most common cause of suboptimal vision with frequent necessity of further treatments. Late post-operative management is complicated by other problems, such as posterior synechiae and secondary glaucoma. The significance of the standardised nomenclature and grading systems, for example the system of the Standardisation of Uveitis Nomenclature working group (SUN) criteria, for evaluating inflammation and clinical decision-making has been emphasised in the medical literature. Nevertheless, there remains a paucity of standardized algorithms to assist the surgeon in determining when surgery should be performed, the most appropriate technique to utilize and the perioperative approach to fit the varied phenotypic presentations of uveitic cataracts[5]. This study seeks to fill this gap by assessing clinical and surgical decision-making in the treatment

of uveitic cataracts at an academic referral center. We aim to determine factors affecting visual recovery and complication rates by prospectively recording patient variables, inflammatory status, surgical options, and perioperative management and subsequently to correlate these with postoperative outcome. Recognition of these determinants will aid in the optimization of personalized surgical planning, and better prognostication.

MATERIALS AND METHODS

Study Design and Setting: Design This is a prospective observational cohort study carried out in aconducted at Department of Ophthalmology of Era's Lucknow Medical College and Hospital from September 2017 to October 2018. The protocol was approved by the institutional review board and the study was conducted in accordance with Declaration of Helsinki. Informed consent was provided by all subjects prior to enrolment.

Study Population: Patients at least 18 years of age with clinically diagnosed uveitic cataract needing surgical treatment were included. All types of anatomic uveitis (anterior, intermediate, posterior and panuveitis) were enrolled following examination and appropriate imaging. Patients who presented with traumatic cataracts or cataracts of etiologies other than uveitis, advanced glaucomatous optic neuropathy, or other ocular co-morbidities likely to preclude visual fulguration were excluded. Also, those unwilling or unable to adhere to the follow-up intervals were excluded.

Preoperative Assessment: All participants underwent a full ophthalmologic examination. This involved a measurement of best-corrected Snellen visual acuity and the results were converted into logMAR units for the purpose of statistical analysis. Slit lamp biomicroscopy for, Goldman applanation tonometry for intraocular pressur, dilated fundus examination, optical coherence tomography (OCT) for macular status were performed as a part of the standard investigation. Ocular inflammation was quantified according to the Standardization of Uveitis Nomenclature (SUN) criteria, recording anterior chamber cells and flare, vitreous haze and retinal involvement. The period of quiescence, the interval from the most recent episode of active inflammation to the planned date of surgery, was registered.

Decision to Perform the Surgery and Surgery: The decision on timing of cataract surgery was personalized and depended on clinical judgment of control of inflammation., surgeons typically aimed for at least 3 months of quiescence if possible. Surgical procedures were conducted with peribulbar or topical anesthesia by experienced ophthalmologists. Cataract type, such as density and ocular condition and doctor's preference were considered during cataract surgery including type of surgery (phacoemulsification or manual small incision cataract surgery(MSICS)) and type of intraocular lens (IOL) either foldable acrylic or PMMA.

Perioperative Management: The choice of perisurgical anti-inflammatory therapy was individualized. Depending on the severity of the inflammation and the systemic health, oral corticosteroids, periocular steroid injections, or a combination of both were given. Regular postoperative and preoperative treatment included systemic corticosteroids and cycloplegic agents to suppress inflammation and prevent synechiae, typical of every case of dacryocystorhinostomy.

Postoperative Follow-Up: The patients were routinely followed up on postoperative day 1, weeks 1, months 1 and 3. Best-corrected visual acuity (BCVA), intraocular pressure and slit-lamp examination were recorded at each visit. OCT was repeated as needed clinically, especially for evaluation and follow-up of CME.

Outcome Measures: The primary endpoint was visual recovery, which was defined as an increase of two lines or more on the Snellen chart at three months after ptosis surgery. Secondary outcomes were the incidence of postoperative complications like cystoid macular edema, posterior synechiae and rise in intraocular pressure.

Data Collection and Analysis: Prospective data recording in standardised case record form was done for clinical and surgical decision making. Statistical analysis was performed with [identify statistical software used, e.g., SPSS version XX]. Baseline demographic and clinical attributes were described by means of descriptive statistics. Chi-square or Fisher's exact tests were performed to explore associations of decision-making factors with visual outcomes for categorical factors and Student's t-test or Mann-Whitney U test for continuous factors. Variables that had a p-value <0.1 on univariate analysis were included in multivariate logistic regression to determine the independent predictors for visual improvement. respect and 9.26 to infinity beyond 1000 L, respectively.

RESULTS AND DISCUSSIONS

Patient Demographics and Clinical Characteristics: A total of 123 patients diagnosed with uveitic cataracts were included in the study. The mean age was 42.5±14.3 years, with a gender distribution of 55.3%

male and 44.7% female. Anterior uveitis was the most prevalent subtype (50.4%), followed by posterior (26.8%) and intermediate uveitis (22.8%). The median duration of quiescence prior to surgery was 3.2 months (IQR: 2.0-5.5). At the time of surgery, 63.4% of patients exhibited no active inflammation (Grade 0), while 36.6% had mild residual inflammation (Grade 1+). Detailed baseline characteristics are summarized in (Table 1).

Table 1: Demographic and Clinical Characteristics of Patients (n=123)

Variable	Frequency (n)	Percentage (%)	Mean ± SD / Median (IQR)
Age (years)	-	-	42.5±14.3
Gender			
Male	68	55.3	
Female	55	44.7	
Uveitis Type			
Anterior	62	50.4	
Intermediate	28	22.8	
Posterior	33	26.8	
Duration of Quiescence (months)	-	-	3.2 (2.0-5.5)
Preoperative Inflammation (SUN Grading)			
Grade 0 (quiet)	78	63.4	
Grade 1+	45	36.6	

Surgical Decision-Making and Perioperative Management: Surgical intervention was undertaken after a minimum of three months of quiescence in 66.7% of patients, reflecting a conservative approach. Phacoemulsification was the preferred surgical technique (77.2%), with foldable acrylic intraocular lenses (IOLs) implanted in 74% of cases. Perioperative corticosteroid therapy included oral administration in 58.5% and periocular injections in 41.5% of patients. These data are detailed in (Table 2).

Table 2. Surgical Decision-Making and Perioperative Management (n=123)

Factor	Frequency (n)	Percentage (%)
Timing of Surgery		
>3 months quiescence	82	66.7
<3 months quiescence	41	33.3
Surgical Technique		
Phacoemulsification with IOL	95	77.2
MSICS	28	22.8
IOL Type		
Foldable acrylic	91	74.0
PMMA	32	26.0
Perioperative Steroid Regimen		
Oral steroids	72	58.5
Periocular steroids	51	41.5

Postoperative Outcomes at 3 Months: At three months postoperatively, 71.5% of patients demonstrated an improvement of two or more Snellen lines in visual acuity. The mean best-corrected visual acuity (BCVA) improved significantly from 1.1±0.5 logMAR preoperatively to 0.5±0.4 logMAR postoperatively. The most frequently observed complications were cystoid macular edema (14.6%), elevated intraocular pressure (12.2%) and posterior synechiae (9.8%). These outcomes are presented in (Table 3).

Association Between Decision Factors and Visual Outcomes: Univariate analysis indicated that surgery performed after >3 months of quiescence was significantly associated with improved visual outcomes (73.9% vs. 48.6%, p=0.01). Although oral steroid use and absence of preoperative inflammation showed a trend toward better outcomes, these did not reach statistical significance. Surgical technique was not significantly associated with visual improvement. Full results are shown in (Table 4).

Table 3: Postoperative Outcomes at 3 Months (n=123)

Outcome	Frequency (n)	Percentage (%)	Mean±SD / Median (IQR)
Visual Acuity			
Improvement >2 lines	88	71.5	-
Complications			
Cystoid Macular Edema	18	14.6	
Posterior Synechiae	12	9.8	
Raised Intraocular Pressure	15	12.2	
Mean BCVA			
Preoperative (logMAR)	-	-	1.1 ± 0.5
Mean BCVA			
Postoperative (logMAR)	-	-	0.5 ± 0.4

Table 4: Association Between Key Decision Factors and Visual Outcome (>2 Lines Improvement)

Factor	Visual Improvement Yes (n=88)	Visual Improvement No (n=35)	p-value*
Surgery after >3 months quiescence	65 (73.9%)	17 (48.6%)	0.01
Oral Steroids (peri-op)	56 (63.6%)	16 (45.7%)	0.08
Surgical Technique (Phaco vs MSICS)	68 (77.3%)	27 (77.1%)	0.98
Preoperative Inflammation Grade 0	60 (68.2%)	18 (51.4%)	0.09

*Statistical test: Chi-square or Fisher's exact test

Multivariate Logistic Regression Analysis: Multivariate logistic regression identified surgery after >3 months of quiescence as an independent predictor of significant visual improvement (OR 2.8, 95% CI: 1.2-6.5, p=0.015). Other variables, including preoperative inflammation status and perioperative oral steroid use, showed positive but non-significant associations. Age was not a significant predictor. Results are detailed in (Table 5).

Table 5: Logistic Regression for Predictors of Visual Improvement (=2 Lines)

Predictor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Surgery after >3 months quiescence	2.8	1.2 - 6.5	0.015
Preoperative Inflammation Grade 0	1.9	0.9 -4.2	0.08
Oral Steroids (peri-op)	1.7	0.8-3.9	0.12
Age (per 10-year increase)	0.85	0.6 -1.2	0.33

Despite advances in the timing of surgical intervention and pre-and postoperative perioperative management, uveitic cataracts remain surgically challenging and continue to be a difficult clinical scenario because of the interplay between ongoing ocular inflammation, surgical timing and perioperative interventions. Our prospective 123-patient study offers a view on the most important factors of surgical decision making with regard to postoperative visual results and complications.

Patient Population and Time to Surgery: The demographic characteristics of our cohort are consistent with the literature on uveitis, where anterior uveitis is the most common type responsible for cataract development. The relatively young average age in our patients explains the different cohort

affected by uveitic cataracts as compared to the age-related cataract in their older counterparts. The timing of the operation was found to be somewhat of a determining sequencing factor. The majority of patients were operated on after >3 months of quiescence of inflammation, which was significantly related to a better visual outcome. That is consistent with the current commonly accepted clinical practice of waiting for inflammation to be under control before performing surgery in order to minimize postoperative complications (cystoid macular edema and posterior synechiae)[6,7].

Surgical Technique and Choice of Lens: Phacoemulsification with foldable, acrylic IOL implantation showed to be frequently performed, because it can provide a minimally invasive surgical approach with swift visual recovery. Manual Small Incision Cataract Surgery still holds merit in some situations, especially when dense cataracts or lack of resources are encountered. We offer comparative visual results between both techniques which are not dissimilar when used as per indications. The general tendency to favor foldable acrylic lenses may be due to their greater biocompatibility and lower inflammatory potential with respect to rigid lens materials. However, selection of intraocular lens should be personalized according to patient status, disease severity and surgeon's experience[8].

Perioperative Steroid Therapy: Oral or periocular steroids were routinely prescribed perioperatively as a means to suppress surgical inflammation. Oral steroid use trended towards better outcomes, but did not achieve statistical significance within our cohort. Personalised steroid regimens based on disease activity and patient tolerance are still necessary for achieving best outcomes.

Visual Results and Complications: Notably, most of the patients gained functionally after surgery, suggesting that even in the case of complicated inflammatory cataracts, good recovery of vision may be possible. The general side effects profile corresponded to the known risks of the population and cystoid macular edema was the most common side effect, then increased intraocular pressure and posterior synechiae. Rapid identification and treatment of these complications is essential in attempting to maintain vision[9].

Independent Risk Factors for Improved Vision: Delay between surgery and inflammation quiescence was the best independent predictor of postoperative visual recovery. This justifies the need of adequate preoperative inflammation control. Other factors including preoperative inflammation grade and perioperative steroid use had positive trends with but were not significant associated with surgical success, suggesting multi factorial impact on the surgical success. Patient age was not an independent predictor of outcome, implying that inflammatory control may supersede age-related causes for determining visual prognosis in uveitic cataract surgery[10,11].

Clinical Implications: Our results underscore the importance of stringent control of intraocular inflammation before surgery. Surgery should be postponed until at least 3 months of quiescence, whenever possible, to optimize visual benefit and minimize complications. Phacoemulsification with foldable acrylic lenses in combination with tailored perioperative corticosteroids is the optimal surgical treatment.

Limitations and the Next Step: Limitation Our study has a prospective design and detailed decision-making data; nevertheless, its single-center design and moderate sample size are limitations. In addition, longer term follow-up is required to assess the longevity of visual results and later postoperative complications. Optimized steroids protocols, newer anti-inflammatory therapies and predictive modelling to refine personalised surgical planning are considerations for future research.

CONCLUSION

The key to surgical success in managing uveitic cataracts is largely related to gaining tight control of the intraocular inflammation before the operation. A dormant phase of 3 months or more brings about a marked improvement in postoperative visual acuity as well as that complications are reduced. Phacoemulsification and foldable acrylic intraocular lens implantation facilitated with individualized perioperative steroid treatment is a safe and efficient alternative for such challenging cases. Personalized surgical planning with respect to inflammation and patient characteristics is crucial for success. More studies should be conducted with larger sample size and longer follow-up to improve perioperative management and establish predictive model for personalized treatment in uveitic cataract surgery.

Declarations:

Consent for Publication: Not applicable. No identifiable personal information or images are included in this manuscript.

Availability of Data and Materials: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests: The authors declare that they have no competing interests.

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