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COMPARISON OF INTRA-OPERATIVE SUBTENON TRIAMCENOLONE ACETONIDE INJECTION WITH POST-OPERATIVE TOPICAL STEROID IN PHACOEMULSIFICATION

Original Research

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ABSTRACT

Background: Postoperative inflammation remains a common and potentially vision-threatening complication after phacoemulsification. Conventional topical corticosteroid regimens, while effective, are often hindered by poor patient compliance, especially in low-resource settings. Depot steroid delivery systems such as sub-Tenon's triamcinolone acetonide offer a promising alternative by ensuring sustained anti-inflammatory effects with reduced dosing frequency.

Objective: To compare the effectiveness of intraoperative sub-Tenon's triamcinolone acetonide injection with postoperative topical steroids in preventing inflammation after uncomplicated phacoemulsification.

Methods: A randomized controlled trial was conducted at the Department of Ophthalmology, Khyber Teaching Hospital, involving 74 patients (aged 40–80 years) undergoing phacoemulsification. Patients were randomly allocated into two equal groups: Group A received a single intraoperative sub-Tenon's injection of triamcinolone acetonide (40 mg/ml), while Group B was treated with 0.1% dexamethasone eye drops postoperatively. The primary outcome was the absence of inflammation, defined by anterior chamber cells ≤3 per high power field or absence of posterior synechiae, assessed at 4 weeks post-surgery.

Results: At 4 weeks follow-up, 83.8% of patients in Group A exhibited no signs of inflammation compared to 59.5% in Group B. The difference was statistically significant. Stratification analysis further revealed higher effectiveness among educated participants and urban residents. No significant adverse effects were noted in either group.

Conclusion: Intraoperative sub-Tenon's triamcinolone acetonide was more effective than postoperative topical steroids in controlling inflammation after phacoemulsification. Its ease of administration and reduced reliance on patient compliance support its integration into routine cataract surgery protocols, particularly in populations where adherence to postoperative regimens is limited.

Keywords: Anti-Inflammatory Agents, Cataract Extraction, Corticosteroids, Eye Inflammation, Intraoperative Care, Phacoemulsification, Sub-Tenon's Injection.

INTRODUCTION

Cataract remains a leading cause of avoidable blindness globally, affecting individuals across both developing and developed nations. While it may present unilaterally or bilaterally, timely diagnosis and surgical intervention followed by appropriate refractive correction are essential for achieving optimal visual outcomes. However, early surgical management, particularly in the form of phacoemulsification, is often complicated by postoperative inflammation and the risk of secondary glaucoma (1). Conventional postoperative care relies heavily on systemic and intensive topical corticosteroids to mitigate these inflammatory responses. Despite their effectiveness, such regimens are frequently associated with significant drawbacks, including steroid-induced ocular hypertension and systemic side effects, both of which tend to be dose- and age-dependent (2,3). Moreover, patient compliance with frequent postoperative eye drop administration remains a critical issue, particularly among individuals from lower socioeconomic backgrounds. Poor adherence can result in subtherapeutic drug concentrations within the eye, thereby diminishing treatment efficacy and potentially compromising surgical outcomes (4). This challenge underscores the need for alternative drug delivery methods that offer both clinical efficacy and ease of use. In response, newer corticosteroid formulations and delivery systems are being explored to enhance patient outcomes and simplify postoperative care (5). Among these, triamcinolone acetonide—a corticosteroid widely utilized in ophthalmology for managing uveitis, aiding in vitreoretinal procedures, and controlling postoperative inflammation—has garnered significant attention (6).

Sub-Tenon's administration of triamcinolone acetonide (STA) represents a promising modality, providing sustained intraocular drug release with fewer systemic effects. A recent study in adults undergoing cataract surgery demonstrated that STA could effectively control postoperative inflammation and serve as a reliable alternative to topical steroids (7,8). Supporting this, a study reported that only 16.6% of patients receiving STA developed posterior synechiae, compared to 50% of those treated with topical steroids, highlighting its superior anti-inflammatory profile (9,10). Given the significant burden of postoperative care on patients, especially those with limited access to medical resources, there is a compelling need to evaluate the clinical utility of intraoperative STA as a primary strategy for inflammation control following cataract surgery. Despite its established use in other ocular procedures, limited evidence exists regarding its efficacy as a standalone anti-inflammatory treatment in uncomplicated phacoemulsification. Therefore, this study aims to address this gap by comparing the effectiveness of a single intraoperative sub-Tenon's injection of triamcinolone acetonide with the conventional postoperative topical steroid regimen. The objective is to determine which method more effectively prevents postoperative inflammation, thereby guiding clinical practice toward more accessible, cost-effective, and patient-compliant postoperative management strategies.

METHODS

This randomized controlled trial was conducted at the Department of Ophthalmology, Khyber Teaching Hospital, Peshawar, over a period of six months following approval of the research synopsis by the Institutional Review Board. Ethical clearance was obtained prior to the commencement of the study, and written informed consent was secured from all participants after explaining the nature, benefits, and risks of the study in their native language. The study aimed to compare the effectiveness of intraoperative sub-Tenon's injection of triamcinolone acetonide with conventional postoperative topical steroid therapy in preventing inflammation following phacoemulsification. A total of 74 patients were enrolled using a non-probability consecutive sampling technique. Sample size was calculated using OpenEpi software based on anticipated effectiveness rates of 83.4% for intraoperative sub-Tenon's triamcinolone acetonide and 50.0% for postoperative topical steroids, with a power of 80% and confidence level of 95%, yielding 37 patients per group (7). Patients aged 40 to 80 years of either gender undergoing phacoemulsification for senile cataract were included. Patients with traumatic cataract, pre-existing glaucoma, ocular tumors, systemic diseases associated with cataracts, or known hypersensitivity to triamcinolone acetonide were excluded to maintain homogeneity and minimize confounding factors.

Patients were randomly assigned into two equal groups (Group A and Group B) using blocked randomization, with both groups matched for age to eliminate age-related bias. Baseline demographics such as age, gender, BMI (kg/m²), laterality of cataract, residence, education, profession, and socioeconomic status were recorded on a predesigned data collection proforma. Preoperative assessment included detailed ocular history and examination comprising best-corrected visual acuity, fixation pattern, pupillary reaction, and direct

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distant ophthalmoscopy. Slit-lamp biomicroscopy was performed for anterior segment evaluation, and intraocular pressure was measured using the Goldmann applanation tonometer. Morphological classification of cataract was documented under pupil dilation, and dilated indirect ophthalmoscopy was performed where possible. For patients in whom the fundus could not be visualized due to dense cataract, B-scan ultrasonography was employed to rule out posterior segment pathology (11-13). All surgical procedures were carried out by a single experienced consultant ophthalmologist under local or peribulbar anesthesia, ensuring consistency across cases. A standard 3.2 mm clear corneal limbal incision was made, followed by phacoemulsification using ultrasound energy. Lens fragments were aspirated using a bimanual irrigation/aspiration technique, and a foldable intraocular lens was implanted into the capsular bag. In Group A, immediately after lens implantation, a single 0.5 ml (40 mg/ml) dose of triamcinolone acetonide was injected into the posterior sub-Tenon's space using a curved blunt cannula attached to a 1 ml syringe. Group B received no such injection.

Postoperatively, Group A patients were prescribed only moxifloxacin 0.5% eye drops four times daily for two weeks. In contrast, Group B patients were administered moxifloxacin 0.5% eye drops four times daily alongside 0.1% dexamethasone eye drops instilled hourly, which were tapered gradually over four weeks (14,15). All patients were discharged on the second postoperative day after receiving training on eye drop administration. Follow-up examination was scheduled at four weeks post-surgery, during which slit-lamp biomicroscopy was used to evaluate anterior segment inflammation, including anterior chamber cells and posterior synechiae, in accordance with operational definitions. Data were entered and analyzed using IBM SPSS version 25. Continuous variables such as age and BMI were assessed for normality using the Shapiro-Wilk test and reported as means with standard deviations. Categorical variables such as gender, eye laterality, residence, education, and treatment effectiveness (defined as absence of inflammation) were reported in frequencies and percentages. The primary outcome—treatment effectiveness—was compared between the two groups using the chi-square test or Fisher's exact test where applicable, with a p-value ≤ 0.05 considered statistically significant. Stratification was performed to control for potential effect modifiers including age, gender, BMI, residence, and socioeconomic status. Post-stratification analysis was also conducted using the chi-square or Fisher's exact test.

RESULTS

The study analyzed data from 74 patients who underwent phacoemulsification, equally divided into Group A (intraoperative sub-Tenon's triamcinolone acetonide) and Group B (postoperative topical steroid therapy). The demographic characteristics were comparable across both groups. The mean age was 62.2 ± 3.1 years in Group A and 61.8 ± 3.4 years in Group B. The average BMI was 26.5 ± 2.3 in Group A and 26.8 ± 2.7 in Group B. Group A comprised 56.8% males and 43.2% females, whereas Group B included 48.6% males and 51.4% females. Most participants in both groups were from lower to middle socioeconomic backgrounds, with 59.5% of Group A and 62.2% of Group B reporting employment. In terms of residence, urban participants constituted 54.1% in Group A and 51.4% in Group B, while rural dwellers made up the rest. Educational status showed 62.2% of Group A and 59.5% of Group B were educated. Laterality of cataract was evenly distributed, with a slight predominance of right-eye involvement in both groups. Regarding the primary outcome measure—postoperative effectiveness defined by the absence of inflammation at four weeks—Group A showed a significantly higher effectiveness rate. In Group A, 31 out of 37 patients (83.8%) demonstrated no signs of inflammation postoperatively, compared to 22 out of 37 patients (59.5%) in Group B. In Group A, only 6 patients (16.2%) showed signs of inflammation, whereas 15 patients (40.5%) in Group B had persistent inflammatory signs such as anterior chamber cells or posterior synechiae at follow-up.

Stratification by education level showed a higher proportion of effectiveness among educated participants in both groups, with 86.4% of educated individuals in Group A showing no inflammation versus 64.7% in Group B. Among uneducated participants, effectiveness dropped to 80% in Group A and 53.3% in Group B. Effectiveness was marginally higher among urban residents compared to rural, but no statistically significant urban-rural disparity was observed within the groups. However, across the entire sample, urban residents demonstrated slightly better outcomes, possibly due to better compliance or healthcare literacy. In summary, the intraoperative sub-Tenon's triamcinolone acetonide group showed a superior postoperative inflammatory control rate compared to the conventional postoperative topical steroid group. The results also suggest that educational status may play a contributory role in treatment outcomes, likely via compliance pathways.

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Table 1: Demographics Summary

Variable	Group A	Group B
Age (mean ± SD)	62.2 ± 3.1	61.8 ± 3.4
BMI (mean ± SD)	26.5 ± 2.3	26.8 ± 2.7
Gender (%)		
Male	56.8%,	48.6%,
Female	43.2%	51.4%
Socioeconomic Status (%)		
Lower	43.2%	40.5%
Middle	32.4%	35.1%,
Upper	24.3%	24.3%
Occupation Status (%)		
Employed	67.6%,	73.0%,
Unemployed	32.4%	27.0%
Residence (%)		
Urban	54.1%,	51.4%
Rural	45.9%	48.6%
Education (%)		
Educated	62.2%	59.5%
Uneducated	37.8%	40.5%
Laterality (%)		
Right	51.4%,	54.1%,
Left	48.6%	45.9%

Table 2: Effectiveness by Group

Group	No	Yes
A	6	31
B	15	22

Table 3: Effectiveness by Education

Group	Education	No	Yes
A	Educated	3	19
A	Uneducated	3	12
B	Educated	8	15
B	Uneducated	7	7

Table 4: Effectiveness by Residence

Group	Residence	No	Yes
A	Rural	5	18
A	Urban	1	13
B	Rural	4	10
B	Urban	11	12

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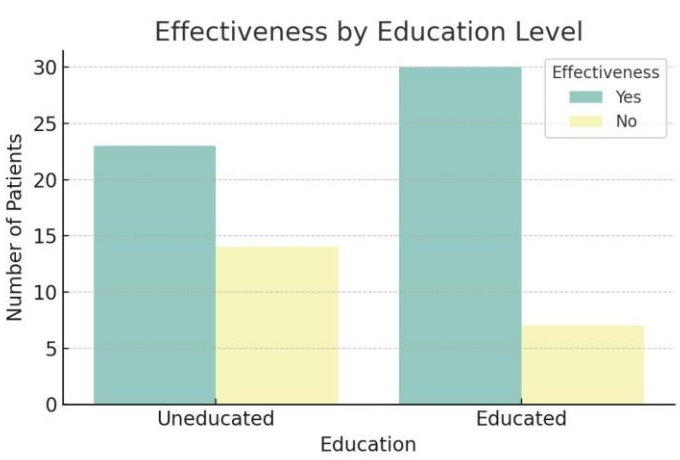

Figure 1 Effectiveness by Education Level

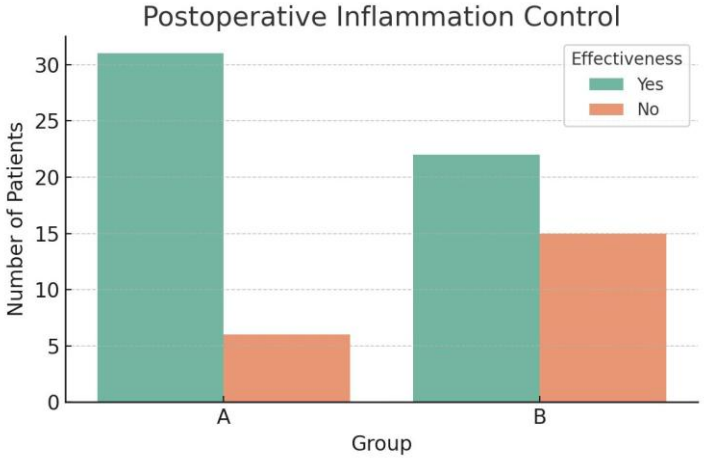

Figure 2 Postoperative Inflammation Control

DISCUSSION

The findings of the present study demonstrated that a single intraoperative sub-Tenon's injection of triamcinolone acetonide was significantly more effective in preventing postoperative inflammation after phacoemulsification compared to the conventional regimen of postoperative topical steroids. Specifically, 83.8% of patients in the sub-Tenon group remained inflammation-free at four weeks, whereas only 59.5% achieved the same in the topical steroid group. This evidence reinforces the hypothesis that depot steroid administration provides superior inflammation control due to sustained intraocular corticosteroid levels and improved compliance, particularly in settings where adherence to frequent topical regimens is challenging. These results align closely with those of a study, which observed superior outcomes in terms of anterior chamber inflammation with posterior sub-Tenon's triamcinolone compared to topical steroids in pediatric cataract surgery, reporting fewer instances of severe inflammation in the injection group (16,17). Similarly, a study found that adding sub-Tenon triamcinolone to a topical dexamethasone regimen significantly improved postoperative outcomes such as central macular thickness and visual acuity, with no additional ocular hypertension (18).

Several other studies support the current findings by comparing alternative corticosteroid delivery systems. A study evaluated intracameral triamcinolone and observed effective inflammation control without notable intraocular pressure elevation, aligning with the present study's emphasis on the safety of intraocular steroid administration (19). Likewise, a study demonstrated that intracameral triamcinolone achieved comparable efficacy to topical dexamethasone, with a noted advantage in patient compliance due to single-dose administration (20). The primary strength of this study lies in its randomized controlled design and matched demographic profiles across groups, minimizing selection and confounding biases. Moreover, using objective clinical criteria such as slit-lamp grading for anterior chamber cells and posterior synechiae strengthens the validity of the outcome measures. The study also addresses a practical and critical challenge in cataract care: ensuring postoperative treatment adherence among patients with low health literacy or socioeconomic constraints. Nonetheless, certain limitations must be acknowledged. First, the sample size, although statistically calculated, remains modest, and results should be interpreted cautiously in terms of generalizability. Second, the follow-up period was restricted to four weeks, which may not fully capture long-term inflammatory complications, steroid-induced intraocular pressure changes, or posterior capsule opacification. Larger studies with extended follow-up would provide more comprehensive safety profiles. Moreover, while intraoperative steroid administration offers improved compliance, risks of depot steroid use, such as delayed steroid response or secondary glaucoma, require vigilance in future assessments.

Another limitation is the lack of blinding in postoperative assessment, which might introduce detection bias. Future research should consider a double-blind approach and incorporate standardized inflammation scoring systems. Furthermore, while posterior sub-Tenon's injection provides consistent results, comparison with intracameral and subconjunctival routes in multicenter trials may help identify the optimal delivery strategy tailored to specific patient populations and healthcare settings. The study contributes valuable insights into simplifying postoperative care in cataract surgery by demonstrating that a single sub-Tenon's injection can be both efficacious and

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patient friendly. As highlighted by a study depot steroid alternatives like triamcinolone may offer a viable strategy for enhancing adherence and reducing postoperative complications, especially in high-volume surgical practices or underserved regions (21,22). In conclusion, the study underscores that intraoperative sub-Tenon's triamcinolone acetonide represents an effective and potentially superior alternative to traditional postoperative steroid drops in controlling inflammation following phacoemulsification. While the safety profile appears favorable, larger trials with longer follow-up and comparative arms are needed to confirm its long-term efficacy and safety.

CONCLUSION

This study concludes that a single intraoperative sub-Tenon's injection of triamcinolone acetonide is a safe, effective, and patient-compliant alternative to conventional postoperative topical steroids for controlling inflammation following phacoemulsification. Its use significantly reduced postoperative inflammatory signs, offering a practical solution, especially in populations with limited adherence to topical therapy. These findings support broader adoption of depot steroid strategies in cataract surgery to optimize outcomes.

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