ORIGINAL ARTICLE

A Comparison of Intracameral with Topical Dexamethasone to Control Immediate Post-Surgical Intraocular Inflammation Following Phacoemulsification: A Quasi-Experimental Study

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ABSTRACT

Objective: To compare the effectiveness and safety of preoperative intracameral dexamethasone versus postoperative topical dexamethasone in controlling immediate intraocular inflammation following phacoemulsification.

Study Design: Quasi-experimental comparative study.

Place and Duration of Study: This study was conducted at the Outpatient Department, Ophthalmology Department, Benazir Bhutto Hospital, Rawalpindi, Pakistan, from August 2024 to November 2024.

Methods: Following Institutional Research Forum approval and written informed consent, eligible patients undergoing uncomplicated phacoemulsification were enrolled. Patients were non-randomly allocated into two intervention groups: the intracameral dexamethasone group (0.1 mL of 0.4 mg/mL administered at the end of surgery) and the topical dexamethasone group (0.1% eye drops administered postoperatively). The primary outcome was effectiveness, defined as the absence of, or minimal, anterior chamber inflammation (SUN grade 0 or trace) on postoperative Day 3, assessed by slit-lamp bio microscopy. Safety outcomes included measuring intraocular pressure, assessing anterior chamber flare as a postoperative inflammatory finding, and evaluating for toxic anterior segment syndrome.

Results: The mean age of participants was 57.01 ± 5.41 years, with 76.7% aged 50-60 years. Effectiveness was significantly higher in the intracameral dexamethasone group (73.3%) compared to the topical dexamethasone group (23.3%) (P< 0.001). Postoperative inflammatory findings and safety outcomes, including raised intraocular pressure and toxic anterior segment syndrome, were infrequent and did not differ significantly between groups.

Conclusion: Intracameral dexamethasone is more effective than topical dexamethasone for controlling immediate postoperative intraocular inflammation following phacoemulsification, without an increased risk of adverse outcomes. Its targeted delivery provides reliable early control of inflammation while reducing dependence on postoperative topical therapy.

Keywords: *Dexamethasone, IntracameralInjection, Phacoemulsification, Postoperative Intraocular Inflammation.*

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Introduction

Cataract surgery, particularly phacoemulsification, is one of the most commonly performed ophthalmic procedures worldwide and is widely regarded as a safe and effective intervention for visual rehabilitation.[1] Despite advances in surgical techniques and instrumentation, immediate postoperative intraocular inflammation remains a

predictable physiological response to surgical trauma and requires appropriate management to ensure optimal visual outcomes and patient comfort.[2] Surgical manipulation of intraocular tissues leads to the release of inflammatory mediators, which may result in anterior chamber reaction, pain, photophobia, and delayed visual recovery if inadequately controlled.[3,4]

Corticosteroids have been the cornerstone of postoperative inflammation control in cataract surgery since the mid-twentieth century due to their potent anti-inflammatory properties.[5]

Dexamethasone, a synthetic corticosteroid, exerts its effect by inhibiting inflammatory cell migration, reducing vascular permeability, and suppressing cytokine release within ocular tissues.[6] Traditionally, corticosteroids are administered via topical eye drops; however, topical therapy is limited by variable drug penetration, delayed onset of action, and dependence on patient adherence, which may compromise early postoperative inflammation control.[7]

Intracameral administration of corticosteroids has emerged as an alternative approach to delivering the drug directly to the anterior chamber during surgery.[8,9]

This method allows immediate drug availability at the site of inflammation, uniform intraocular distribution, and reduced reliance on postoperative topical regimens. Several studies have suggested that intracameral corticosteroids may provide effective early inflammation control without increasing the risk of postoperative complications when used under appropriate sterile conditions.[9,10]

However, despite growing interest in intracameral steroid use, comparative data evaluating its effectiveness against conventional topical dexamethasone in routine clinical practice remain limited, particularly in non-randomized settings. Clear evidence is required to determine whether intracameral administration offers superior control of immediate postoperative inflammation while maintaining a comparable safety profile.

Therefore, the objective of this study was to compare the effectiveness and safety of preoperative intracameral dexamethasone versus postoperative topical dexamethasone in controlling immediate intraocular inflammation following phacoemulsification, with effectiveness defined using standardized clinical criteria.

Methods

This quasi-experimental comparative study was conducted in the Outpatient Department of Ophthalmology at Benazir Bhutto Hospital in Rawalpindi from August 2024 to November 2024. Ethical approval was obtained from the Research and Ethical Committee of the hospital, vide letter no: 400/IREF/RMU/2023, dated: 13th July 2023, and written informed consent was secured from all participants prior to enrollment.

A total of 60 patients of either gender, aged 50 to 70 years, undergoing uncomplicated phacoemulsification for age-related cataract were included using a non-probability consecutive sampling technique. The sample size was calculated using the World Health Organization formula for comparing two independent proportions, assuming an expected effectiveness of 66.7% in the intracameral dexamethasone group and 26.7% in the topical dexamethasone group, with a 5% significance level and 80% study power. The calculated sample size was 30 patients per group.

Patients with a history or presence of uveitis, raised intraocular pressure, uncontrolled diabetes mellitus, hypermature cataract, previous ocular trauma, or known hypersensitivity to dexamethasone or other corticosteroids were excluded.

All surgical procedures were performed by consultant ophthalmologists with more than five years of post-fellowship experience using a standardized phacoemulsification technique. The investigators were not involved in postoperative outcome assessment.

The independent variable in this study was the route of dexamethasone administration, categorized as intracameral or topical. Participants were non-randomly allocated into two intervention groups. Group A received intracameral dexamethasone administered as 0.1 mL of 0.4 mg/mL injected into the anterior chamber at the completion of surgery, while Group B received topical dexamethasone 0.1% eye drops postoperatively according to the institutional protocol.

The primary dependent variable was treatment

effectiveness, defined as absence or minimal anterior chamber inflammation corresponding to Standardization of Uveitis Nomenclature (SUN) grade 0 or trace, assessed on postoperative Day 3 using slit-lamp bio microscopy.

The secondary outcomevariables included postoperative intraocular pressure measured with a Goldmannapplanation tonometer, the presence of anterior chamber flare, recorded as a postoperative inflammatory finding on slit-lamp examination, and clinical evidence of toxic anterior segment syndrome, all assessed on postoperative Day 3.

Descriptive variables, including age, gender, area of residence, and operated eye, were recorded to characterize the study population and were not included in inferential or subgroup analyses.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. The Chi-Square test was applied to compare categorical outcomes between the two groups. A *P*-value of ≤ 0.05 was considered statistically significant.

Continuous variables, including age (years), were expressed as mean ± standard deviation. Categorical variables, including gender (male/female), area of residence (urban/rural), operated eye (right/left), route of dexamethasone administration (intracameral/topical), treatment effectiveness (yes/no), raised intraocular pressure (yes/no), presence of anterior chamber flare (yes/no), and toxic anterior segment syndrome (yes/no), were expressed as frequencies and percentages. The chi-square test was applied to compare categorical variables between the two groups. A *P*-value of ≤ 0.05 was considered statistically significant.

Results

A total of 60 patients undergoing uncomplicated phacoemulsification were included in the study, with 30 patients in each treatment group. The mean age of the study population was 57.01 ± 5.41 years. Most participants (76.7%) were aged 50-60 years, while 23.3% were older than 60 years (Table 1).

Table 1: Distribution of patients by age (N = 60)

Variable	Value
Mean age (years)	57.01 ± 5.41
50–60 years	46 (76.7%)
>60 years	14 (23.3%)

Table 2: Baseline demographic and clinical characteristics of study participants

Variable	Intracameral Group (N = 30)	Topical Group (N = 30)
Age (years), mean ± SD	56.10 ± 5.12	57.93 ± 5.63
Male	11 (36.7%)	16 (53.3%)
Female	19 (63.3%)	14 (46.7%)
Urban residence	13 (43.3%)	9 (30.0%)
Rural residence	17 (56.7%)	21 (70.0%)
Right eye operated	17 (56.7%)	19 (63.3%)
Left eye operated	13 (43.3%)	11 (36.7%)

Baseline demographic and clinical characteristics were comparable between the intracameral and topical dexamethasone groups. The mean age in the intracameral group was 56.10 ± 5.12 years, while in the topical group it was 57.93 ± 5.63 years. Gender distribution, area of residence, and operated eye showed no significant differences between the two groups (Table 2).

Effectiveness, defined as the absence or minimal anterior chamber inflammation (SUN grade 0 or trace) on postoperative Day 3, was observed in 22 patients (73.3%) in the intracameral dexamethasone group compared to 7 patients (23.3%) in the topical dexamethasone group. This difference was

Table 3: Comparison of effectiveness and safety outcomes between groups (N = 60)

Outcome	Response	Intracameral Group (N = 30)	Topical Group (N=30)	*Chi-Square/ Fisher's Exact*	RR (CI)	*P* value
Effectiveness	Yes	22 (73.3%)	7 (23.3%)	15.016	RR = 3.14 95% CI: 1.59–6.20	< 0.001
	No	8 (26.7%)	23 (76.7%)			
Raised intraocular pressure	Yes	2 (6.7%)	4 (13.3%)	0.741	RR= 0.50 (95% CI: 0.10-2.54)	0.38
	No	28 (93.3%)	26 (86.7%)			
Anterior chamber flare	Yes	1 (3.3%)	2 (6.7%)	0.351	RR=0.50 (95% CI:0.05–5.24)	0.55
	No	29 (96.7%)	28 (93.3%)			
Toxic anterior segment syndrome	Yes	0 (0.0%)	1 (3.3%)	1.017	RR=0.33*	0.31
	No	30 (100.0%)	29 (96.7%)			

*Note: Fisher's exact test was used for safety outcomes because of small, expected frequencies. RR = Relative Risk; CI = Confidence Interval. *RR for TASS is continuity-adjusted due to zero events in the Intracameral group; confidence interval is not reported because the estimate is unstable.*

- *Fisher's exact test is used for outcomes with small counts (<5 per cell).*
- *Chi-square test is used for effectiveness because all expected counts ≥5.*

statistically significant (χ^2 = 15.016, *P*< 0.001). Regarding safety outcomes, raised intraocular pressure was observed in 2 patients (6.7%) in the intracameral group and 4 patients (13.3%) in the topical group (*P* = 0.38). Anterior chamber flare, recorded as a postoperative inflammatory finding, was noted in 1 patient (3.3%) in the intracameral group and 2 patients (6.7%) in the topical group (*P* = 0.55). Toxic anterior segment syndrome was observed in 1 patient (3.3%) in the topical group, while no cases were reported in the intracameral group (*P* = 0.31). No statistically significant difference was observed between groups for safety outcomes (Table 3).

Discussion

The findings of the present study demonstrate a significant early advantage of intracameral dexamethasone in reducing postoperative intraocular inflammation when compared with topical dexamethasone following phacoemulsification. On postoperative Day 3, a substantially higher proportion of patients in the intracameral group showed no inflammation or minimal anterior chamber reaction (SUN grade 0 or trace) than those in the topical group (73.3% vs 23.3%, *P*< 0.001). These results indicate greater early anti-inflammatory efficacy of intracameral dexamethasone during the immediate postoperative period and directly address the study's primary outcome.

This observation is consistent with the existing literature, which demonstrates that intracameral corticosteroid administration provides higher, more predictable intraocular drug concentrations during the early postoperative phase while avoiding limitations of topical therapy, such as variable corneal penetration and inconsistent dosing.[11-13] Although patient compliance was not directly evaluated in the present study, intracameral administration theoretically eliminates adherence-related challenges commonly encountered with topical regimens, particularly in older patients. This pharmacokinetic advantage likely contributes to the improved inflammatory control observed at postoperative Day 3 in our cohort.

Several studies have supported the efficacy of intracameral corticosteroids in managing postoperative inflammation after cataract surgery. Elkhodary N et al. reported significantly lower anterior chamber cell and flare grades in patients

receiving intracameral corticosteroids compared with topical therapy during early postoperative assessments; however, their study primarily evaluated triamcinolone acetonide rather than dexamethasone.[14] Similarly, Gautam M et al. demonstrated superior early inflammatory outcomes with intracameral steroid administration across different corticosteroid formulations.[15] While these findings reinforce the benefit of the intraocular route, extrapolation across different steroid agents should be interpreted cautiously due to variations in pharmacokinetic and pharmacodynamic properties. Importantly, studies that have raised concerns regarding long-term ocular effects emphasize the need for extended follow-up rather than disputing the early efficacy of intracameral steroids.[16]

Regarding safety, the present study found no statistically significant difference between the intracameral and topical dexamethasone groups in early postoperative adverse events. Elevated intraocular pressure was observed in 6.7% of patients in the intracameral group and 13.3% in the topical group, with no statistically significant difference between the two. These findings suggest comparable short-term safety within the constraints of the study sample size rather than definitive equivalence between the two routes of administration. Similar results have been reported by Dole K et al., who found no significant increase in postoperative complications associated with intracameral steroid use following cataract surgery.[17] Furthermore, broader reviews indicate that toxic anterior segment syndrome related to intracameral injections is uncommon and more frequently associated with procedural factors rather than the corticosteroid agent itself.[13,16]

The demographic characteristics of the study population further support the applicability of these findings. The mean age of participants was 57.01 years, with most older than 50 years, reflecting the typical population undergoing cataract surgery.[12] The comparable age distribution between treatment groups minimizes potential age related confounding and strengthens the internal validity of the comparative analysis. Similar age-matched populations have been emphasized in prior cataract surgery outcome studies to ensure reliable interpretation of treatment effects.[17,18]

The present findings also align with broader evidence supporting the use of intracameral steroids in cataract surgery. A systematic review by ChoopongPet al. reported that intracameral corticosteroids, across various formulations, consistently provided superior early postoperative control of inflammation compared with topical regimens.[19] Additionally, pharmacologic comparisons suggest that dexamethasone offers a rapid onset of action and a shorter intraocular half-life compared with agents such as triamcinolone, which may reduce the risk of prolonged intraocular pressure elevation while maintaining effective early anti-inflammatory activity.[13,20] HowaidyA et al. similarly demonstrated that intraocular anti-inflammatory strategies provide favorable clinical outcomes without increasing postoperative complications when compared with conventional topical approaches.[21] El Haddad N further emphasized the importance of selecting an appropriate administration route to optimize postoperative outcomes following phacoemulsification.[22]

Several limitations of the present study should be acknowledged. The single-center design and relatively small sample size may limit the detection of rare adverse events. In addition, the follow-up period was limited to postoperative Day 3, which restricts conclusions regarding sustained inflammatory control, late onset complications, and long-term visual outcomes. Masking was not employed, and patient reported outcome measures were not assessed. These factors should be considered when interpreting the results.

This study provides evidence that intracameral dexamethasone is more effective than topical dexamethasone in controlling early postoperative inflammation following phacoemulsification when assessed at postoperative Day 3, without an observed increase in short-term adverse events. Within the limitations of early follow-up and sample size, these findings support the preferential use of intracameral dexamethasone for early postoperative inflammation control. Future multicenter studies with larger sample sizes and longer follow-up durations are warranted to further evaluate long-

term safety, durability of inflammatory control, and broader clinical outcomes.

Conclusion

It is concluded that, in order to reduce acute postoperative intraocular inflammation after phacoemulsification, intracameral dexamethasone treatment was found to be more effective than topical dexamethasone. The intracameral route provides a rapidmedications and ensuring consistent drug delivery to the site of inflammation. Moreover, both treatment methods were found to be safe, with no significant differences in postoperative complications such as raised intraocular pressure, flare, or toxic anterior segment syndrome. Therefore, intracameral dexamethasone can be considered a reliable and efficient alternative to topical therapy for managing early postoperative inflammation in cataract surgery.

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Author Contributions

HK: Conception and design of the work
MBK: Manuscript writing for methodology design and investigation
SA: Validation of data, interpretation, and write-up of results
ZH: Data acquisition, curation, and statistical analysis
FAK: Writing the original draft, proofreading, and approval for final submission