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Topical 0.5% Proparacaine Alone versus Topical 0.5% Proparacaine Combined with 1% Intracameral Lidocaine for Intraoperative Pain Control in Phacoemulsification: A Quasi-Experimental Study

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None declared

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ABSTRACT

Objective: To compare patient-reported intraoperative pain during phacoemulsification performed with topical 0.5% proparacaine alone versus the same topical anaesthesia supplemented with 1% intracameral lidocaine.

Methods: In this single-centre, quasi-experimental comparative study at the Department of Ophthalmology, Unit-I, King Edward Medical University/Mayo Hospital, Lahore, 114 adults with age-related cataract were consecutively enrolled and assigned alternately to two equal groups. Group A (n = 57) received topical 0.5% proparacaine; Group B (n = 57) also received 0.2 mL preservative-free 1% intracameral lidocaine. Pain experienced during surgery was rated immediately after the procedure on an 11-point numerical rating scale (NRS, 0–10). Between-group differences were evaluated using the Mann–Whitney U test and Fisher's exact test.

Results: Mean NRS scores were 3.19 ± 0.72 (median 3, IQR 1) in Group A and 1.60 ± 0.68 (median 2, IQR 1) in Group B; the unadjusted difference in means was 1.60 points (95% CI 1.34–1.86; Mann–Whitney U = 220, $p < 0.001$). Moderate pain (NRS 4–6) was reported by 19/57 (33.3%) and 1/57 (1.8%) patients, respectively ($p < 0.001$). Mean age differed between the groups (57.9 ± 5.6 vs 60.7 ± 6.2 years; $p = 0.013$).

Conclusion: Topical proparacaine supplemented with intracameral lidocaine was associated with lower immediately recalled intraoperative pain than topical proparacaine alone. The nonrandomized allocation, lack of masking and baseline age difference limit causal interpretation.

Keywords: Cataract; Phacoemulsification; Topical anaesthesia; Proparacaine; Intracameral lidocaine; Pain measurement; Numerical rating scale.

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INTRODUCTION

Cataract is a leading cause of treatable visual impairment worldwide, with substantial unmet surgical needs in low- and middle-income countries (1). Phacoemulsification with implantation of a foldable intraocular lens is a widely used approach to age-related cataract surgery because small-incision techniques allow rapid postoperative recovery (2,3). Topical anaesthesia is commonly used for routine phacoemulsification because it avoids needle-related complications associated with retrobulbar or peribulbar blocks and facilitates perioperative care (4,5). Comparative studies from South Asia have also explored pain and patient comfort under topical versus peribulbar anaesthesia (6,7). Nevertheless, topical agents such as 0.5% proparacaine primarily anaesthetise the ocular surface; manipulation of the iris and other intraocular structures may still cause discomfort (8).

Intracameral lidocaine is administered directly into the anterior chamber as an adjunct to topical anaesthesia. A Cochrane review of randomized trials found that supplementary intracameral lidocaine produced a modest average reduction in intraoperative pain, although the clinical magnitude was uncertain (9). A subsequent prospective comparison reported less pain with combined topical and intracameral anaesthesia (10), and a Pakistani study evaluated intracameral lignocaine alongside other analgesic approaches for phacoemulsification (11). Research involving intracameral anaesthetic combinations has also examined their intraoperative performance in cataract procedures (12). Despite this evidence, reported pain varies across settings, protocols and patients, and there is a need for centre-specific evaluation of the commonly used 0.5% proparacaine regimen, with or without preservative-free intracameral lidocaine, in public tertiary cataract services. The present study therefore compared pain reported immediately after phacoemulsification in patients receiving topical 0.5% proparacaine alone or topical 0.5% proparacaine supplemented with 1% intracameral lidocaine. The prespecified hypothesis was that reported pain would be lower with the combined regimen.

METHODS

Study design and setting

This single-centre, quasi-experimental comparative study was conducted in the Department of Ophthalmology, Unit-I, King Edward Medical University/Mayo Hospital, Lahore, Pakistan, a public-sector tertiary referral service. Participants undergoing routine phacoemulsification were enrolled consecutively and assigned to one of two anaesthetic regimens by an alternating, nonrandomized allocation sequence. The Institutional Review Board of King Edward Medical University approved the study (No. 437/RC/KEMU, dated 13 July 2024). Written informed consent was obtained from all participants, and the study followed the principles of the Declaration of Helsinki.

Sample size and participant selection

A sample of 114 participants (57 in each group) was planned for a two-sided comparison of independent mean pain scores, assuming a standardized mean difference (Cohen's d) of 0.53, 80% power and a 5% type-I error rate. Under equal allocation, the normal-approximation calculation n per group $\approx 2(Z_{1-\alpha/2} + Z_{1-\beta})^2/d^2$ gives approximately 56 participants per arm; the target was set at 57 per arm. Recruitment used non-probability consecutive sampling until the planned group sizes were reached.

Eligibility criteria

Adults older than 30 years with uncomplicated age-related cataract scheduled for phacoemulsification under topical anaesthesia were eligible. Participants were required to have intraocular pressure within the normal clinical range, no known hypersensitivity to proparacaine or lidocaine and no painful ocular condition. Exclusion criteria were glaucoma, uveitis, corneal disease, active ocular infection, uncontrolled diabetes mellitus or hypertension, cognitive impairment or neurological deficits affecting reliable pain reporting, and refusal to participate. Cataract appearance was classified clinically on slit-lamp examination as nuclear sclerosis (NS grades 1–4), cortical, posterior subcapsular (PSC) or mixed cataract.

Allocation and anaesthetic interventions

Eligible participants were assigned alternately in their order of enrolment: Group A received topical 0.5% proparacaine alone and Group B received the same topical preparation with additional 1% intracameral lidocaine. Both groups received three drops of 0.5% proparacaine hydrochloride at five-minute intervals before surgery and a further drop after preparation of the eye with 5% povidone-iodine. In Group B, 0.2 mL of preservative-free 1% lidocaine was injected into the anterior chamber through the side-port incision immediately after paracentesis. Allocation was not randomized or concealed.

Surgical procedure

Consultant ophthalmic surgeons experienced in phacoemulsification performed the procedures using a temporal clear-corneal approach, continuous curvilinear capsulorhexis, hydrodissection, divide-and-conquer or stop-and-chop nucleus removal according to surgeon preference, irrigation–aspiration of residual cortex, and in-the-bag implantation of a foldable intraocular lens. Neither intravenous nor oral sedation was administered.

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Outcome assessment

The primary endpoint was patient-reported pain experienced during surgery. Each patient was introduced preoperatively to the numerical rating scale (NRS), an 11-category pain intensity measure ranging from 0 (no pain) to 10 (worst pain imaginable) (13). Immediately after surgery, before leaving the operating theatre, the patient rated the pain experienced during the operation; the response was entered on a structured proforma. For description, pain was classified as none (0), mild (1–3), moderate (4–6) or severe (7–10). The form also captured age, sex, hospital registration number, cataract type/grade and eligibility information.

Statistical analysis

Statistical analyses were performed in SPSS version 24 (IBM Corp., Armonk, NY, USA). Age was summarized as mean ± standard deviation (SD) and compared between groups using an independent-samples t-test. Categorical characteristics were expressed as counts and percentages. NRS responses were summarized by mean ± SD, median (interquartile range [IQR]), range and individual score frequencies. Because the NRS was ordinal with a non-normal distribution, its principal unadjusted between-group comparison used the Mann–Whitney U test; the corresponding rank-based effect size was $r = |Z|/\sqrt{N}$. The unadjusted mean difference and a two-sided 95% confidence interval were calculated from the group-specific summary statistics using the independent-samples standard error. The proportion reporting moderate pain (NRS 4–6) was compared using Fisher's exact test. All tests were two-sided, with $p < 0.05$ considered statistically significant.

RESULTS

Participant characteristics

All 114 enrolled participants (57 per group) completed phacoemulsification and the immediate postoperative pain rating. The sample comprised 58 men (50.9%) and 56 women (49.1%). Nuclear sclerosis grades 1 and 2 accounted for 95/114 (83.3%) cataracts. Participants in Group B were, on average, 2.8 years older than those in Group A ($p = 0.013$; Table 1).

Table 1. Baseline age by group and clinical characteristics of the full study cohort (N = 114)

Characteristic	Group A (n=57)	Group B (n=57)	Overall (N=114)
Age (years), mean ± SD	57.9 ± 5.6	60.7 ± 6.2	
Age (years), median (IQR)	58 (9)	61 (9)	
Age range (years)	50–71	47–72	
Sex: male			58 (50.9%)
Sex: female			56 (49.1%)
Cataract: NS grade 1			64 (56.1%)
Cataract: NS grade 2			31 (27.2%)
Cataract: NS grade 3			3 (2.6%)
Cataract: NS grade 4			1 (0.9%)
Cataract: cortical			8 (7.0%)
Cataract: NS + PSC			4 (3.5%)
Cataract: PSC			3 (2.6%)

The mean age differed between groups (independent-samples t-test, $p = 0.013$). Sex and cataract classifications are shown as overall cohort totals. SD, standard deviation; IQR, interquartile range; NS, nuclear sclerosis; PSC, posterior subcapsular cataract.

Intraoperative pain

The mean NRS score was 3.19 ± 0.72 in Group A and 1.60 ± 0.68 in Group B (Table 2). Based on the reported score frequencies, the unadjusted difference in mean scores was 1.60 points (95% CI 1.34–1.86). The distribution was shifted toward lower pain scores in Group B (Mann–Whitney $U = 220$, $Z = -8.25$, $p < 0.001$; $r = 0.77$). The median pain score was 3 (IQR 1) versus 2 (IQR 1).

Table 2. Summary of intraoperative pain intensity by treatment group

Measure	Group A (n=57)	Group B (n=57)	Between-group result

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Measure	Group A (n=57)	Group B (n=57)	Between-group result
NRS, mean ± SD	3.19 ± 0.72	1.60 ± 0.68	Mean difference 1.60 (95% CI 1.34–1.86)
Median (IQR)	3 (1)	2 (1)	U = 220; p < 0.001
Range	2–5	0–4	
Mean rank	82.1	32.9	r = 0.77

NRS, numerical rating scale (0–10); SD, standard deviation; IQR, interquartile range; CI, confidence interval. The Mann–Whitney U test was the primary unadjusted comparison. Mean difference: Group A minus Group B.

Moderate pain (NRS 4–6) was reported by 19/57 patients (33.3%) in Group A compared with 1/57 (1.8%) in Group B, an unadjusted absolute difference of 31.6 percentage points (Fisher's exact p < 0.001). None of the patients in Group A rated pain as 0 or 1, whereas 26/57 (45.6%) did so in Group B. No participant in either group reported severe pain (NRS 7–10). Table 3 presents the individual score distribution, illustrated in Figure 1.

Table 3. Distribution of patient-reported intraoperative pain scores

NRS score	Group A, n (%)	Group B, n (%)	Total, n (%)
0 (no pain)	0 (0.0)	1 (1.8)	1 (0.9)
1	0 (0.0)	25 (43.9)	25 (21.9)
2	9 (15.8)	28 (49.1)	37 (32.5)
3	29 (50.9)	2 (3.5)	31 (27.2)
4	18 (31.6)	1 (1.8)	19 (16.7)
5	1 (1.8)	0 (0.0)	1 (0.9)
Mild pain (1–3)	38 (66.7)	55 (96.5)	93 (81.6)
Moderate pain (4–6)	19 (33.3)	1 (1.8)	20 (17.5)

No NRS scores of 6–10 occurred. Percentages use n = 57 as the denominator within each study group and N = 114 for total values. Fisher's exact p < 0.001 for moderate pain.

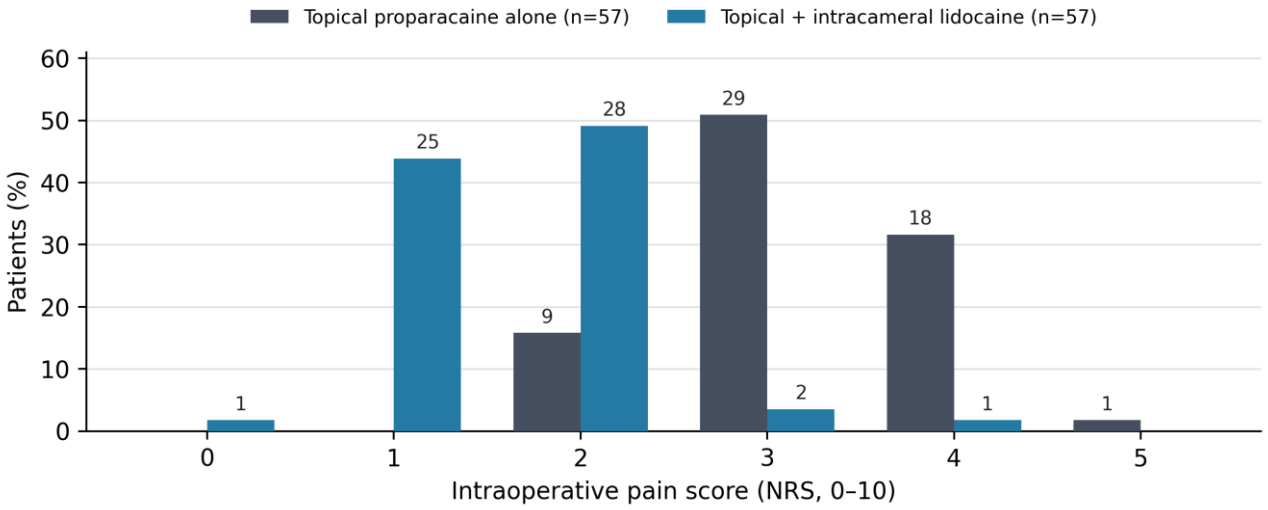


Figure 1. Patient-reported intraoperative pain after phacoemulsification, by anaesthetic regimen. Bars represent the percentage of patients in each group; numbers over the bars are observed counts. There were no scores above 5.

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DISCUSSION

In this single-centre, nonrandomized comparison, patients receiving intracameral lidocaine in addition to topical proparacaine reported lower pain immediately after phacoemulsification than patients receiving topical proparacaine alone. The group mean difference was 1.60 NRS points, and moderate pain occurred in 33.3% versus 1.8% of participants. The separation was evident across the distribution of ordinal pain ratings rather than only at the highest values. These are unadjusted associations and should be interpreted in light of the allocation method and age imbalance. The direction of the observed difference is consistent with the Cochrane review of randomized trials, which reported a smaller pooled reduction in intraoperative pain with supplemental intracameral lidocaine (9). Ripa et al. found lower intraoperative and early postoperative discomfort with topical plus intracameral anaesthesia than with topical anaesthesia alone (10). In a Pakistani comparison, Munir et al. likewise reported favourable intraoperative pain results with intracameral lignocaine-containing regimens, although the interventions and assessment methods were not identical (11). Together, these studies support a potential analgesic benefit, but the substantially larger difference in our cohort warrants cautious interpretation rather than an assumption of superior treatment efficacy.

An anatomical explanation is plausible. Proparacaine administered topically predominantly affects surface ocular sensory endings, whereas lidocaine in the anterior chamber may supplement anaesthesia during intraocular manipulation (8,9). Evidence from other cataract techniques using intracameral lidocaine-containing combinations provides complementary, though not directly interchangeable, information (12). The present NRS assessment captured overall recalled operative pain rather than discomfort attributable to specific manoeuvres, so it cannot establish which step benefited most. Patient factors may have influenced the comparison. The mean age was 2.8 years higher in Group B, and the nonrandomized sequence could not ensure equivalence in clinical and procedural characteristics. Previous reports have associated pain during cataract surgery with patient characteristics and the operative experience (17); Zhu et al. identified associations between preoperative anxiety and perceived surgical pain (16). Rekik et al. examined preoperative anxiety and postoperative pain under local anaesthesia (18), while a systematic review and a regression study emphasized fear, information needs and patient comfort (19,20). Accordingly, differences in anxiety, age and other unmeasured influences cannot be excluded as alternative explanations for part of the observed association.

Pain control is relevant to the experience of cataract surgery, but comfort and surgical safety should be distinguished from pain-score findings alone. Randomized trials have evaluated other anaesthetic adjuncts (14,15,21), and reports of patient and surgeon perspectives support the importance of individualized perioperative management (22,23). Educational and environmental interventions, including comfort measures and eyelid-speculum lubrication, may also improve the cataract surgery experience (24,26). The present results support further evaluation of intracameral lidocaine as one option within comprehensive perioperative care; they do not establish reductions in operative movement, complications or later postoperative pain. Corneal and intraocular safety are also important when selecting intracameral medication. The Cochrane review assessed ocular toxicity alongside pain outcomes (9). A pooled 2024 analysis of a commercially prepared intracameral mydriatic–anaesthetic formulation reported reassuring comparative safety findings, including endothelial measures (25). Nevertheless, that formulation differs from preservative-free lidocaine alone, and the present pain comparison should not be interpreted as an independent evaluation of endothelial safety.

Strengths and limitations

Strengths include a clearly defined two-regimen comparison, identical topical proparacaine schedules, use of an established 0–10 pain scale, complete pain ratings among the enrolled participants and presentation of the full score distribution. The analysis also includes an effect estimate and confidence interval for the observed difference.

Important limitations arise from alternating rather than random allocation and the absence of blinding, which permit selection, performance and expectation bias. Group B was older than Group A, and the unadjusted comparisons cannot separate the anaesthetic association from differences in baseline or operative characteristics. Sex and cataract characteristics are summarized for the complete cohort rather than by treatment group; procedures were undertaken by more than one surgeon, using either divide-and-conquer or stop-and-chop techniques according to preference. A single immediate postoperative assessment may introduce recall or response bias and cannot localize pain to particular surgical steps. The study was conducted at one tertiary centre, and its findings should not be generalized to complex cataract surgery or alternative anaesthetic protocols without further investigation.

CONCLUSION

In this quasi-experimental study, topical 0.5% proparacaine supplemented with 1% intracameral lidocaine was associated with lower patient-reported intraoperative pain than topical proparacaine alone during phacoemulsification. Confirmation in prospectively registered, randomized and assessor-masked studies with balanced baseline characteristics and standardized operative conditions is warranted.

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DECLARATIONS

Ethical approval: Approved by the Institutional Review Board, King Edward Medical University, Lahore (No. 437/RC/KEMU, dated 13 July 2024).

Informed consent: Written informed consent was obtained from all participants.

Authors' contributions: Sarfraz Ahmad: conception and design, data collection, analysis and drafting of the manuscript. All listed authors approved the final version.

Data availability: The data are available from the corresponding author on reasonable request.

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