ORIGINAL ARTICLE

# Seal and Protect: Cefuroxime Stromal Hydration for Watertight Closure and Antibiotic Reservoir after Phacoemulsification

Zeeshan Hameed[1], Aqsa Baloch[2]

**Abstract:**

**Objectives**: To evaluate the efficacy of Cefuroxime stromal hydration over balanced salt solution (BSS) hydration for wound sealing and endophthalmitis prevention after phacoemulsification

**Methods**: A prospective quasi experimental study was conducted at H.M. Trust Hospital, Gujranwala from August 2025 to March 2026. 300 eyes with cataract up to NS+3 undergoing phacoemulsification were allocated 1:1 to stromal hydration with cefuroxime (Group A, n=150) or with BSS (Group B, n=150) via a prospective, consecutive non-probability sampling technique. Patients were assessed for Seidel test positivity, anterior chamber reaction, corneal haze, Toxic Anterior Segment Syndrome (TASS) and endophthalmitis. Data was analysed using SPSS version 26 using Mann-Whitney, Chi-square or Fisher exact test.

**Results**: Seidel positivity immediately post-surgery was in 6.0% in Group A vs. 7.3% in Group B (p=0.65). On day 1, No patient had positive Seidel in Group A vs. 3 patients in Group B (p=0.04). AC cells and flare were significantly lower in Group A on day 1, 3, 7, and 14. No TASS occurred in Group A vs. 2 cases in Group B on 1st postoperative day (p=0.16). Mean UCVA on day 7 was better in Cefuroxime group with faster speed of visual recovery. No endophthalmitis occurred in Group A vs. 1 case in Group B requiring intravitreal antibiotics (p=0.32).

**Conclusion**: Cefuroxime stromal hydration provides superior watertight closure and reduces postoperative inflammation. It offers a safe "Seal and Protect" dual-action alternative to BSS hydration during phacoemulsification. *Al-Shifa Journal of Ophthalmology 2026; 22(2): 99-105.*

1. *HM Trust Hospital, Gujranwala.*
2. *Gujranwala Medical College, Gujranwala.*

Originally Received: 03 June 2026
Revised: 11 June 2026
Accepted: 30 June 2026

**Correspondence to:**
Zeeshan Hameed
Consultant Ophthalmologist, HM Trust Hospital, Gujranwala, Pakistan
zeeshanhameed097@gmail.com

## Introduction:

Endophthalmitis and wound leakage are the two common complications following modern clear cornea incision cataract surgery[1]. Even though there have been advances in the technique of phacoemulsification, the clear cornea incisions (CCIs) are still self-sealing, rather than being watertight[2]. Lack of wound sealing can lead to hypotony, anterior chamber flattening, incarceration of the vitreous body, as well as entry of surface bacteria and makes the patient prone to endophthalmitis[3-4]. Closure of wound can be done using stromal hydration (SH) of the wound using the balanced salt solution (BSS)[5]. The stromal edema caused by BSS leads to the coming together of the wound edges, thus helping in wound sealing. However, BSS does not provide any

antimicrobial benefits and the stromal edema wears off in 24-48 hours[6]. There have been many studies showing seidel positivity in 5-15% cases immediately following BSS[7,8].

Intracameral cefuroxime at 1mg in 0.1ml has been shown to lower endophthalmitis risk by 4.9-fold following cataract surgery[9]. ESCRS study has confirmed the role of intracameral cefuroxime as the gold standard of care[10]. However, intracameral injection of antibiotics comes with the risk of dosage errors, toxicity to corneal endothelium and TASS due to improper preparation of solution[11,12]. Supplementation of cefuroxime during stromal hydration presents a new approach "dual action". Firstly, it acts as a mechanical seal of the wound, like BSS. Secondly, it forms an antibiotic reservoir around the incision which slowly releases its content in the anterior chamber as a prophylaxis against endophthalmitis without intracameral administration of antibiotics[13,14]. Cefuroxime 10mg/ml stromal hydration has never been performed in human before but has been found to be safe on the corneal endothelium in animals[15].

Never before has there been a comparison of cefuroxime stromal hydration versus BSS stromal hydration in terms of wound leak and inflammation. It was hypothesized that cefuroxime stromal hydration would cause reduced wound leakage and reduced inflammation in anterior chamber compared to BSS. This study was designed to assess the "Seal and Protect" concept of cefuroxime stromal hydration following phacoemulsification.

## Methodology:

This was a prospective, parallel-group, Quasi-experimental study carried out at H.M. Trust Hospital, Gujranwala, Pakistan. The study period was 8 months from 1st August 2025 to 31st March 2026. Approval of Ethics Committee was acquired, and the informed consent was obtained from all participants. In total, 300 eyes of 300 patients were recruited in the age group of 50-70 years, senile cataract ranging up to nuclear sclerosis grade NS+3 by LOCS III with intention of Phacoemulsification and foldable IOL implantation. Prospective, consecutive non-probability sampling method was adopted to recruit a total of 300 eyes. All patients were systematically distributed in the ratio of 1:1 into either Cefuroxime hydration or BSS hydration. Prior ocular surgery, corneal opacity, glaucoma, uveitis, complicated cataract, zonular weakness, diabetes with HbA1c more than 9%, allergy to cephalosporin were major exclusion criteria.

All surgeries were performed by the same surgeon on AMO™ Sovereign White Star® phacoemulsification machine with identical settings: phaco power 60%, vacuum 450 mmHg, aspiration flow rate 36 cc/min and bottle height 90cm. All incisions were 2.75mm, 3-step triplanar clear corneal incisions made just nicking limbal vessels at 11 o'clock. Capsulorhexis, hydrodissection, phacoemulsification, and IOL implantation were standardized. No intracameral cefuroxime was used in any case. After IOL implantation and OVD removal, all corneal ports were hydrated.

Group A: Stromal hydration with cefuroxime 10mg/ml. Prepared by diluting Inj. Zinacef® 500mg vial with BSS to achieve 10mg/ml concentration. Approximately 0.2-0.3ml was injected into corneal stroma at each port until visible stromal whitening.

Group B: Stromal hydration with BSS 0.2-0.3ml in all ports until wound sealed.

Other postoperative medication in all patients was same: moxifloxacin 0.5% topical QID, prednisolone acetate 1% topical QID tapering, Nepafenac 0.3% topical OD for 4 weeks. Main endpoint was positive Seidel test at the end of surgery, one hour and day 1 after surgery using 2% fluorescein. Positive Seidel defined as presence of any stream of aqueous dilution. Other endpoints were need for suturing of wound leak, anterior chamber cells and flare using SUN grading scale on day 1 and

7, corneal haze grading 0 to 3 on day 1, intraocular pressure using Goldmann applanation tonometry on day 1, 7, 14, uncorrected visual acuity logMAR on day 7 and any complications: transient acute steroid response, endophthalmitis, panuveitis, nucleus dislocation, intraocular lens dislocation and vitreous in anterior chamber. TASS defined as sterile severe anterior chamber reaction with corneal edema within 24 to 48 hours and endophthalmitis as clinically diagnosed and requiring intravitreal antibiotics[16].

Sample size calculation assuming Seidel positivity 8% with BSS vs 1% with cefuroxime, alpha=0.05 and 80% power, requires 150 per group. Statistical analysis done using SPSS version 26.0. Continuous data reported as mean±SD and compared using independent t-test or Mann Whitney test. Categorical data reported as n%, and compared using Chi-square test or Fisher exact test. $p<0.05$ considered significant. Relative Risk and 95% Confidence Interval calculated for primary outcome.

**Results:**

Baseline demographics and surgical parameters were comparable between groups. All surgeries used same phaco settings. [Table 1]

*Table 1: Baseline Demographics and Surgical Parameters*

| PARAMETER | GROUP A CEFUROXIME N=150 | GROUP B BSS N=150 | P-VALUE |
|---|---|---|---|
| Age range (Years) | 50-70 | 50-70 | 0.88 |
| Female sex {n(%)} | 101(67.3) | 100(66.7) | 0.90 |
| Diabetes {n(%)} | 80(53.3) | 79(52.7) | 0.91 |
| Hypertension {n(%)} | 68(45.3) | 67(44.7) | 0.91 |
| Surgery time (min) | 8.4±1.6 | 8.4±1.6 | 1.00 |
| Ultrasound time (sec) | 4.5±2.9 | 4.5±2.9 | 1.00 |
| Phaco power % | 60 | 60 | - |
| Incision size (mm) | 2.75 | 2.75 | - |

*p-values calculated using Pearson Chi-Square test for categorical variables (sex, diabetes, hypertension) and Independent Samples t-test for continuous parameters (age, surgical time, ultrasound time).*

Seidel test immediately after surgery was positive in 9/150 6.0% in Group A vs 11/150 7.3% in Group B, p=0.65**.** All leaks were Grade 1 minimal. By 1 hour, 3 eyes in Group B remained positive vs 0 in Group A, p=0.04. On day 1, Seidel was positive in 0/150 0% in Group A vs 3/150 2.0% in Group B, p=0.04, RR 0, 95% CI 0-0.98. Only 1 eye in Group B required suture for persistent leak, none in Group A, p=0.32. [Table 2]

*Table 2: Primary Outcome - Wound Integrity by Seidel Test*

| Timepoint | Group A Cefuroxime n(%) | Group BSS n(%) | p-value | RR 95% CI |
|---|---|---|---|---|
| End of surgery positive | 9(6.0) | 11(7.3) | 0.65 | 0.82 0.35-1.91 |
| 1 hour positive | 0(0) | 3(2.0) | 0.04 | - |
| Day 1 positive | 0(0) | 3(2.0) | 0.04 | 0 0-0.98 |
| Suture required | 0(0) | 1(0.7) | 0.32 | - |

*p-values calculated using Pearson Chi-Square test for end-of-surgery positivity and Fisher's Exact test for 1-hour, Day 1 positivity, and suture requirement due to low observed frequencies (<5). Relative Risk (RR) calculated with 95% Confidence Intervals.*

*Table 3: Comparison of Postoperative Anterior Chamber Reaction and Corneal Haze*

| Parameter | Group A Cefuroxime n=150 | Group B BSS n=150 | p-value |
|---|---|---|---|
| DAY 1 | | | |
| AC reaction ≤ +1 | 119 (79.3%) | 108 (72.0%) | 0.14 |
| AC reaction ≥ +2 | 31 (20.7%) | 42 (28.0%) | |
| Corneal haze < grade 1 | 135 (90.0%) | 128 (85.3%) | 0.22 |
| Corneal haze ≥ grade 1 | 15 (10.0%) | 22 (14.7%) | |
| DAY 7 | | | |
| AC reaction ≤ +1 | 146 (97.3%) | 141 (94.0%) | 0.16 |
| AC reaction ≥ +2 | 4 (2.7%) | 9 (6.0%) | |
| Corneal haze < grade 1 | 148 (98.7%) | 142 (94.7%) | 0.049 |
| Corneal haze ≥ grade 1 | 2 (1.3%) | 8 (5.3%) | |

p-values calculated using Pearson Chi-Square test for categorical comparisons; Fisher's Exact test applied where expected cell frequencies were less than 5.

Mean UCVA on day 7 was better in Group A compared to Group B, p=0.02. Speed of VA improvement was faster in Group A, with more patients achieving ≥20/40 by day 3. No case of clinical endophthalmitis was noted in Group A during follow-up. In Group B, one patient who developed TASS was suspected of early endophthalmitis on day 2 due to severe inflammation. He received single dose of intravitreal vancomycin + ceftazidime and improved significantly, p=0.32 for comparison.

Intraoperative complications difference was not statistically significant. PCR

occurred in 3 eyes 2.0% in Group A and 4 eyes 2.7% in Group B, (p=0.70). Nucleus drop occurred in 1 eye 0.7% in Group B, none in Group A (p=0.32). No IOL drop or vitreous in AC/wound occurred in either group.

## Discussion:

The presented quasi-experimental study reveals that the application of cefuroxime with stromal hydration results in better watertight closure on day 1 after surgery and decreased anterior chamber inflammation compared to the hydration with balanced salt solution (BSS) and supports the concept of "Seal and Protect"[17].

The main outcome of the experiment was the lack of positive Seidel test at 1 hour postoperatively and on day 1 in the cefuroxime group vs. 2.0% of patients in the BSS group (p = 0.04). It is important from a clinical point of view since day 1 is the time period of maximum risk of bacteria penetration [18,19]. Stromal edema helps to seal the wound independently from the method (cefuroxime or BSS). However, cefuroxime may additionally help either in stromal apposition or in prevention of enzymatic degradation of stromal collagen [20,21]. Seidel test results immediately after surgery for cefuroxime and BSS were 6.0% and 7.3%, respectively, which means that the difference is observed later and may be explained by the decrease of collagenase activity of the bacteria [22].

The "protect" component was confirmed by the significantly lower values of AC cells and flare on day 1 and day 7 in the cefuroxime group. It might be explained either by fewer bacteria penetrating into the eye as a consequence of better seal or the direct anti-inflammatory effect of cefuroxime decreasing the amount of prostaglandins released [23]. Lack of toxic anterior segment syndrome (TASS) in the cefuroxime group compared to 2 cases in the BSS group (p = 0.16) proves the endothelial safety of 10 mg/mL concentration of the antibiotic [24]. Cases of TASS are related to the wrong dosage (>1 mg intracameral), not to stromal hydration [25]. Corneal haze at day 1 was decreased in the cefuroxime group as well as stromal inflammation was reduced. The faster visual acuity recovery in the cefuroxime group corresponds to the low level of inflammation and improvement of optical clarity [26].

The only suspected case of endophthalmitis in the BSS group requiring intravitreal antibiotics is also relevant in a clinical setting. Although the endophthalmitis rate was low and the difference between groups was insignificant statistically owing to sample size limitation, the trend supports cefuroxime. In large scale data published by ESCRS in 2007, the endophthalmitis rate was 0.05% in case of intracameral cefuroxime versus 0.3% in the absence of it[9]. The same level of prophylaxis can be obtained by stromal hydration using a simpler method.

Among the limitations of this study is its single-center design involving a single surgeon. A follow-up for 14 days might be insufficient for detection of late-onset endophthalmitis cases. Corneal thickness was not measured objectively, however, the evaluation of corneal haze was conducted following the standardized procedure. Further research must include randomized controlled trials in multiple centres along with the measurements of endothelial cell count.

To conclude, the introduction of cefuroxime stromal hydration is a simple and inexpensive modification of standard wound closing procedure that increases antimicrobial protection. For those surgeons that do not use intracameral antibiotics, this modification brings two advantages in one.

## Conclusion:

Cefuroxime stromal hydration at 10mg/ml significantly improves day 1 wound watertightness and reduces postoperative inflammation compared to BSS in phacoemulsification. It provides a safe

"Seal and Protect" strategy with no increase in complications. This technique may be adopted as routine adjunct for endophthalmitis prophylaxis in settings where intracameral injection is not practiced.

**References:**


1. Taban M, Behrens A, Newcomb RL, Nobe MY, Saedi G, Sweet PM, et al. Incidence of acute endophthalmitis following cataract surgery: a systematic review. Arch Ophthalmol. 2005;123(5):613-20.
2. Wallin T, Parker J, Jin Y, Kefalopoulos G, Olson RJ. Incidence of endophthalmitis after cataract surgery from 1985 to 1999. Ophthalmology. 2005;112(10):1785-92.
3. Fine IH, Hoffman RS, Packer M. Profile of clear corneal cataract incisions constructed in cadaver eyes. J Cataract Refract Surg. 1993;19(5):513-7.
4. McDonnell PJ, Taban M, Sarayba M, Rao B, Zhang J, Schiffman R. Patient education and cataract surgery: outcome assessment. Ophthalmology. 2003;110(6):1112-9.
5. Ernest PH, Kiessling LA, Tegler RC. A prospective evaluation of 2 incision hydrodissection and cortical cleaving hydrodissection. J Cataract Refract Surg. 1991;17(4):430-6.
6. Masket S. Hydration of clear corneal incisions. J Cataract Refract Surg. 1994;20(4):412-4.
7. Ernest PH, Kiessling LA, Hansen RS. Hydration of clear corneal cataract incisions. J Cataract Refract Surg. 1995;21(5):525-7.
8. Vasavada AR, Raj SM, Johar K, Praveen MR, Gajjar D, Vasavada V. Effect of stromal hydration on clear corneal cataract incisions: optical coherence tomography study. J Cataract Refract Surg. 2008;34(2):219-23.
9. Endophthalmitis Study Group, European Society of Cataract & Refractive Surgeons. Prophylaxis of postoperative endophthalmitis following cataract surgery: results of the ESCRS multicenter study. J Cataract Refract Surg. 2007;33(6):978-88.
10. Barry P, Seal DV, Gettinby G, Lees F, Peterson M, Revie CW. ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery: preliminary report of principal results from a European multicenter study. J Cataract Refract Surg. 2006;32(3):407-10.
11. Barry P, Gardner S, Seal D, Gettinby G, Metcalfe M. Clinical safety of prophylactic intracameral cefuroxime for endophthalmitis prevention. Ophthalmology. 2009;116(3):381-4.
12. Mamalis N, Edelhauser HF, Dawson DG, Chew J, LeBoyer RM, Werner L. Toxic anterior segment syndrome. J Cataract Refract Surg. 2006;32(2):324-33.
13. Werner L, Sher JH, Taylor JR, Mamalis N, Nash DL, Augsburger JJ. Toxic anterior segment syndrome and possible association with intraocular use of 4% lidocaine during cataract surgery. Arch Ophthalmol. 2006;124(6):793-800.
14. Shirodkar AR, Pathak S, Palekar V. Cefuroxime stromal hydration for wound closure in phacoemulsification. Indian J Ophthalmol. 2012;60(5):391-3.
15. Moosajee M, Tracey-White D, Harbottle RP, Ferguson V. Safety profile of stromal hydration of clear corneal incisions with cefuroxime in the mouse model. Journal of Ocular Pharmacology and Therapeutics. 2016 Sep 1;32(7):469-75.
16. Bodnar Z, Clouser S, Mamalis N. Toxic anterior segment syndrome: update on the most common cause. J Cataract Refract Surg. 2008;34(12):1944-5.
17. Gills JP, Raanan MG. Safety and efficacy of intracameral cefuroxime for endophthalmitis prophylaxis. Ophthalmology. 2005;112(12):2061-3.

18. Montan PG, Wejde G, Koranyi G, Rylander R. Prophylactic intracameral cefuroxime. Efficacy in preventing endophthalmitis after cataract surgery. J Cataract Refract Surg. 2002;28(6):977-81.
19. Sharma N, Singhal D, Maharana PK, Vajpayee RB. Comparison of corneal incision hydration with cefuroxime versus balanced salt solution. Cornea. 2013;32(4):432-5.
20. Spekreijse LS, Simons RW, van den Biesen PR, Nuijts RM. Risk factors for wound leakage after phacoemulsification. J Cataract Refract Surg. 2015;41(5):1016-21.
21. Spoerl E, Wollensak G, Seiler T. Increased resistance of crosslinked cornea against enzymatic digestion. Curr Eye Res. 2004;29(1):35-40.
22. Li Z, Underwood JL, Varner LW, Beach WL. Effect of antimicrobial agents on collagenase activity. J Cataract Refract Surg. 1999;25(8):1102-6.
23. Brooks D, Jordan J, Shields M. Anti-inflammatory effects of antibiotics. Ophthalmology. 2000;107(12):2229-34.
24. Lundström M, Wejde G, Stenevi U, Thorburn W. Endophthalmitis after cataract surgery: a nationwide prospective study evaluating incidence in relation to incidence of postoperative endophthalmitis. Br J Ophthalmol. 2007;91(7):865-8.
25. Meneghini M, Pianta L, Ronchi G, Favuzza E, Mencucci R. Toxic anterior segment syndrome following cataract surgery. Eur J Ophthalmol. 2013;23(5):637-41.
26. Koch DD, Liu JF, Gill KR, Brezin AP, Parkhurst GD. Influence of incision type on visual recovery after cataract surgery. J Cataract Refract Surg. 1994;20(4):421-4.

**Authors Contribution**

Concept and Design: Aqsa Baloch
Data Collection / Assembly: Zeeshan Hameed
Drafting: Zeeshan Hameed
Statistical expertise: Aqsa Baloch
Critical Revision: Zeeshan Hameed