

COMPARATIVE ANALYSIS OF CONJUNCTIVAL COMPLICATIONS AND INFECTION RISKS IN SMALL INCISION MANUAL CATARACT SURGERY (SIMICS) VERSUS OTHER CATARACT SURGERY TECHNIQUES

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ABSTRACT

Objective: Objective: This study aims to compare the conjunctival complications and postoperative infections between Small Incision Manual Cataract Surgery (SIMICS) and phacoemulsification.

Materials & Methods: This comparative observational study was conducted at the Department of Ophthalmology, MTI-Khyber Teaching Hospital, Peshawar, from June 2024 to December 2024. A total of 462 patients undergoing cataract surgery were enrolled, with 231 patients in each group (SIMICS and phacoemulsification), selected through non-probability consecutive sampling. Postoperative assessments for conjunctival chemosis, hyperemia, and infections were performed at 1 week, 1 month, and 3 months using slit-lamp biomicroscopy. Data were analyzed using SPSS version 25. Chi-square tests and binary logistic regression were applied; $p < 0.05$ was considered statistically significant.

Results: Conjunctival chemosis was more common in the SIMICS group (27.7%) than in the phacoemulsification group (10.0%) ($p < 0.001$). Conjunctival hyperemia was observed in 39.0% of SIMICS patients, compared to 17.7% in the phacoemulsification group ($p < 0.001$). Postoperative infection rates were also significantly higher in SIMICS (13.0%) versus phacoemulsification (6.5%) ($p = 0.019$). Logistic regression analysis confirmed that surgical technique independently predicted infection ($p = 0.028$), while age, gender, and chemosis were not statistically significant.

Conclusion: SIMICS is linked to a higher rate of conjunctival chemosis, hyperemia, and postoperative infections compared to phacoemulsification. These findings highlight the need to improve surgical techniques and postoperative care, especially in low-resource settings where SIMICS is common.

Keywords: Cataract surgery, Conjunctival chemosis, Conjunctival hyperemia, Endophthalmitis, Phacoemulsification, Small Incision Manual Cataract Surgery.

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INTRODUCTION

Cataract remains the leading cause of reversible blindness worldwide, affecting millions, especially in low- and middle-income countries. ¹ Small Incision Manual Cataract Surgery (SIMICS) has become widely accepted as an effective, affordable, and sutureless procedure that offers quicker recovery and better visual results compared to traditional extracapsular cataract extraction (ECCE) techniques. ² However, concerns about conjunctival complications and post-surgical infections still exist. The con-

junctiva plays a vital role in protecting the ocular surface, and any iatrogenic damage during cataract surgery can increase the risk of infection, delayed healing, and other issues, which can influence surgical outcomes. ³ The extent to which SIMICS impacts conjunctival morbidity compared to other techniques is still not well understood, requiring further research. ⁴

Despite widespread adoption of SIMICS, the literature shows inconsistencies in reported infection rates and conjunctival complications across different populations and surgical settings. International studies have reported varying rates of post-SIMICS conjunctival complications, from mild chemosis to severe infections, with an incidence of postoperative endophthalmitis estimated at 0.01–0.08% in developed healthcare systems. ⁵ In contrast, resource-limited regions with poor sterilization protocols and substandard surgical environments report much higher rates. ⁶ In South Asia, including India and Bangladesh, studies show that conjunctival trauma and infection rates

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after SIMICS range from 0.5% to 2.5%.⁷ However, most of these studies focus on general surgical outcomes rather than specifically examining conjunctival complications.⁸

In Pakistan, cataract surgery makes up over 60% of all ophthalmic procedures done each year, with SIMICS being the preferred method in public hospitals because of its affordability and accessibility.⁹ Despite its benefits, there is a lack of national data on conjunctival morbidity related to this technique. Current studies mainly focus on restoring vision, ignoring the long-term effects on conjunctival health and infection risk.¹⁰ Additionally, there is an absence of comparative data on conjunctival complications between SIMICS and other techniques like phacoemulsification. This gap highlights the need for a detailed assessment of conjunctival complications associated with SIMICS, especially in the Pakistani population, where surgical skills, sterilization practices, and patient follow-up vary greatly.

Cataract remains the leading cause of reversible blindness worldwide, especially in low- and middle-income countries where healthcare resources are limited. Among the various surgical options for cataract removal, Small Incision Manual Cataract Surgery (SIMICS) has become a preferred technique in many public hospitals due to its affordability, minimal equipment needs, and good visual results. Despite its benefits, SIMICS involves manual manipulation and larger incisions, which can increase the risk of conjunctival trauma and postoperative complications. These complications, particularly conjunctival chemosis, hyperemia, and infections, can significantly impact patient recovery, visual rehabilitation, and overall surgical success.

Phacoemulsification, however, is widely seen as the gold standard for cataract surgery in developed healthcare settings because of its minimally invasive approach and reduced tissue handling. It is linked to a lower risk of conjunctival disturbance and infection, although its high equipment costs and the need for specialized training often restrict its use in resource-limited settings.

Although international studies have reported different rates of conjunctival complications between SIMICS and phacoemulsification, there is a clear lack of region-specific data from Pakistan comparing these two techniques regarding conjunctival outcomes. Local literature mainly concentrates on visual acuity and intraoperative metrics, often neglecting ocular surface health and postoperative infection risk, both of which are key factors in patient satisfaction and long-term success.

This study was therefore designed to examine conjunctival complications and postoperative infections between SIMICS and phacoemulsification in a tertiary care setting. By identifying the technique linked to higher morbidity and exploring predictive factors for postop-

erative infection, this research aims to guide clinical decision-making, improve surgical protocols, and optimize postoperative care strategies—especially in settings where SIMICS remains the primary treatment for cataracts due to economic and logistical factors.

MATERIAL AND METHODS

This observational study was carried out at the Department of Ophthalmology, MTI-Khyber Teaching Hospital (MTI-KTH), Peshawar, over a six-month period from June 2024 to December 2024. Ethical approval was secured from the institutional review board of Khyber Teaching Hospital. Patients undergoing cataract surgery, specifically Small Incision Manual Cataract Surgery (SIMICS) and phacoemulsification, were included. A standardized protocol was used to assess postoperative conjunctival complications, such as chemosis, hyperemia, and infection rates.

The sample size was calculated based on infection rates of 0.08% in developed countries and 2.5% in South Asia. Cohen's *h* formula and a power analysis ($\alpha = 0.05$, power = 80%) determined a needed sample of 231 per group. With two groups (SIMICS and phacoemulsification), the total sample size is 462 participants. A non-probability consecutive sampling method will be used to recruit eligible participants. All patients will undergo a comprehensive preoperative evaluation to confirm eligibility. Postoperative follow-ups will be scheduled at one week, one month, and three months to evaluate conjunctival complications.

Patients with pre-existing conjunctival disorders such as pterygium or conjunctivitis, systemic conditions affecting wound healing (e.g., uncontrolled diabetes mellitus or autoimmune diseases), and those with a history of previous ocular trauma or surgery in the same eye were excluded. Written informed consent was obtained from all participants to ensure confidentiality and compliance with the Declaration of Helsinki.

Data collection involved preoperative, intraoperative, and postoperative assessments. Baseline demographic details, medical history, and ocular examination results were recorded. Intraoperative data, including surgical technique, incision size, operative duration, and intraoperative complications, were documented. Postoperative complications were evaluated through slit-lamp biomicroscopy during scheduled follow-up visits.

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics summarized baseline characteristics, and categorical variables, such as conjunctival complications and infection rates, were compared between SIMICS and phacoemulsification with the chi-square test. A *p*-value of <0.05 was deemed statistically significant. Logistic regression analysis identified potential predictors of post-

operative conjunctival complications, and results were displayed in tables and figures.

RESULTS

A total of 462 patients undergoing cataract surgery were included in the study, evenly divided between the two surgical groups: 231 patients underwent Small Incision Manual Cataract Surgery (SIMICS), and 231 underwent phacoemulsification. The gender distribution showed that 105 (45.5%) females and 126 (54.5%) males had phacoemulsification, while 109 (47.2%) females and 122 (52.8%) males had SIMICS. The difference in gender distribution between the two surgical techniques was not statistically significant ($p = 0.709$), indicating that the two groups were comparable in gender. These findings are presented in Table 1.

A statistically significant difference in the incidence of conjunctival chemosis was observed between the two surgical groups. In the SIMICS group, 64 patients (27.7%) developed conjunctival chemosis, while only 23 patients (10.0%) in the phacoemulsification group did. The difference was highly significant ($p < 0.001$), indicating a much higher prevalence of conjunctival chemosis among patients who underwent SIMICS. The comparison of conjunctival chemosis between the two groups is shown in Table 2.

Similarly, the frequency of conjunctival hyperemia was significantly higher in the SIMICS group. A total of

90 patients (39.0%) in the SIMICS group developed conjunctival hyperemia compared to 41 patients (17.7%) in the phacoemulsification group. This difference was statistically significant ($p < 0.001$), indicating that SIMICS is more often associated with conjunctival hyperemia than phacoemulsification. These findings are summarized in Table 3.

The rate of postoperative infections was also significantly higher in the SIMICS group. Thirty patients (13.0%) in the SIMICS group developed infections, compared to 15 patients (6.5%) in the phacoemulsification group. The difference was statistically significant ($p = 0.019$), showing that patients undergoing SIMICS have a higher risk of postoperative infection compared to those undergoing phacoemulsification. The detailed infection rates are shown in Table 4.

To identify independent predictors of postoperative infection, binary logistic regression analysis was conducted. The study found that surgical technique was the only statistically significant predictor of postoperative infection, with SIMICS being linked to a higher risk of infection (Coefficient = 0.7647, $p = 0.0283$). Other variables such as age ($p = 0.6997$), gender ($p = 0.9100$), and conjunctival chemosis ($p = 0.8580$) were not significantly associated with infection risk. This suggests that surgical technique is the main factor influencing postoperative infection outcomes in this cohort. The results of the logistic regression analysis are shown in Table 5.

Table No 1: Comparison of Surgical Technique with respect to Gender (n=462)

		Surgical Technique		Total	P Value
		Phacoemulsification	SIMICS		
Gender	Female	105	109	214	0.709
		45.5%	47.2%	46.3%	
	Male	126	122	248	
		54.5%	52.8%	53.7%	
Total		231	231	462	
		100.0%	100.0%	100.0%	

Table No 2: Comparison of Surgical Technique with respect to Conjunctival Chemosis (n=462)

		Surgical Technique		Total	P Value
		Phacoemulsification	SIMICS		
Conjunctival Chemosis	Yes	23	64	87	< 0.001
		10.0%	27.7%	18.8%	
	No	208	167	375	
		90.0%	72.3%	81.2%	
Total		231	231	462	
		100.0%	100.0%	100.0%	

Table No 3: Comparison of Surgical Technique with respect to Conjunctival Hyperemia (n=462)

		Surgical Technique		Total	P Value
		Phacoemulsification	SIMICS		
Conjunctival Hyperemia	Yes	41	90	131	< 0.001
		17.7%	39.0%	28.4%	
	No	190	141	331	
		82.3%	61.0%	71.6%	
Total		231	231	462	
		100.0%	100.0%	100.0%	

Table No 4: Comparison of Surgical Technique with respect to Infection (n=462)

		Surgical Technique		Total	P Value
		Phacoemulsification	SIMICS		
Infection	Yes	15	30	45	< 0.001
		6.5%	13.0%	9.7%	
	No	216	201	417	
		93.5%	87.0%	90.3%	
Total		231	231	462	
		100.0%	100.0%	100.0%	

Table No 5: Binary Logistic Regression (n=462)

Variable	Coefficient	Standard Error	Z-value	P-value
Surgical Technique	0.7647	0.3486	2.1935	0.0283
Age	-0.0052	0.0134	-0.3857	0.6997
Gender	0.0361	0.3195	0.1130	0.9100
Conjunctival Chemosis	-0.0727	0.4059	-0.1790	0.8580

DISCUSSION

The findings of this study emphasize a significant link between surgical technique and the risk of conjunctival complications and infections after cataract surgery. The increased occurrence of conjunctival chemosis, hyperemia, and disease in the SIMICS group supports previous research suggesting that manual incision techniques may cause more conjunctival trauma than phacoemulsification. ¹¹ Vajpayee et al. reported a higher rate of postoperative conjunctival inflammation in SIMICS compared to phacoemulsification, attributing it to larger incisions and more handling of ocular tissues, which disrupts the conjunctival blood vessels and increases the risk of inflammation and infection. ¹² Similarly, Sharma et al. observed that patients undergoing SIMICS faced a greater risk of transient conjunctival hyperemia and slower ocular surface healing compared to those receiving phacoemulsification. ¹³

While our study showed a significantly higher risk of conjunctival complications in the SIMICS group, the results differ from some studies that report similar safety profiles for both techniques. A meta-analysis by Riaz et al. suggested that, with proper aseptic techniques and improved instrumentation, the risk of infection in SIMICS can

be reduced to levels comparable to those of phacoemulsification. ¹⁴ This difference may be due to variations in surgical expertise, preoperative antiseptic protocols, and patient follow-up compliance across different healthcare settings.

The higher infection rate observed in SIMICS in this study aligns with previous research indicating that larger incisions in manual techniques may increase the risk of microbial entry, especially in resource-limited settings where sterilization protocols might not be optimal. ¹⁵ Studies from South Asia, including Pakistan and India, have reported a higher incidence of post-SIMICS endophthalmitis compared to developed regions, highlighting the importance of strict postoperative care in such environments.

This study provides clear evidence that Small Incision Manual Cataract Surgery (SIMICS) is associated with a significantly higher incidence of conjunctival chemosis, conjunctival hyperemia, and postoperative infections when compared to phacoemulsification. These findings underscore the need for careful consideration of the surgical approach, particularly in healthcare settings where SIMICS is widely practiced due to its affordability and ease of implementation.

While SIMICS remains a viable and cost-effective option for cataract removal—especially in resource-limited settings—it is important to recognize and address its higher risk of conjunctival morbidity. The increased manipulation of ocular tissues and larger incisions associated with SIMICS may cause more conjunctival trauma, leading to inflammation and a greater risk of infection. Therefore, efforts should focus on improving surgical techniques, minimizing tissue handling, and practicing careful intraoperative methods to reduce conjunctival complications. Equally important is enforcing strict postoperative care protocols, including prophylactic antibiotics, standardized wound care instructions, and better patient education. Optimizing sterilization procedures in operating rooms, enhancing surgeon training in gentle tissue handling, and encouraging adherence to postoperative follow-up schedules can significantly lower the risk of complications.

Given the increasing global burden of cataract-related visual impairment and the vital importance of surgical safety for successful outcomes, there is an urgent need for further research. Future studies should examine long-term outcomes beyond the initial postoperative period, evaluate wound healing, and include patient-reported outcome measures, such as ocular comfort and satisfaction. Comparative trials that assess changes to the SIMICS technique, additional antiseptic measures, and innovations in incision design may provide further insights.

This study has certain limitations that should be acknowledged. First, the non-randomized study design may introduce selection bias, as patient allocation to surgical techniques was not randomized. Second, despite efforts to control for confounding factors, variables such as surgeon expertise and postoperative medication adherence may have influenced the outcomes. Additionally, the follow-up duration was limited to three months, which may not capture late-onset complications.¹⁷ Future research should focus on conducting large-scale randomized controlled trials to validate these findings and explore potential modifications in SIMICS to minimize conjunctival trauma and infection risk. Investigating the roles of adjunctive intraoperative antiseptic techniques, improved wound-closure methods, and long-term conjunctival healing patterns could provide valuable insights into optimizing surgical outcomes.¹⁸ Moreover, studies evaluating patient-reported ocular surface discomfort and visual quality after SIMICS versus phacoemulsification would contribute to a more comprehensive understanding of patient-centered outcomes.¹⁹

CONCLUSION

This study shows that SIMICS is linked to a higher rate of conjunctival chemosis, hyperemia, and postoperative infection compared to phacoemulsification. The results emphasize the importance of improving surgical techniques and enhancing postoperative care to reduce

complications. While SIMICS remains a cost-effective option, optimizing sterilization procedures and surgical accuracy is essential for lowering infection risks. Future research should examine long-term outcomes and patient-reported experiences to improve surgical safety and effectiveness. Applying evidence-based practices can help refine cataract surgery methods, leading to better patient results, especially in resource-limited environments.

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Authors Contribution:

Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Israr M	✓	✓	✗	✗	✓	✗
Khan B	✓	✗	✓	✓	✓	✗

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Approval:

This Manuscript was approved by the Ethical Board of Khyber Teaching Hospital, Peshawar. Vide No. 536/DME/KMC.

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