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OPTIMIZING GLAUCOMA MANAGEMENT: A COMPARATIVE STUDY OF TRABECULECTOMY OUTCOMES WITH FORNIX-BASED AND LIMBAL-BASED CONJUNCTIVAL FLAPS

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Abstract:

Background: Glaucoma, characterized by chronic optic neuropathy, visual field loss, and elevated intraocular pressure (IOP), necessitates effective management. Trabeculectomy, a pivotal surgical intervention, involves creating a new drainage pathway. This study explores the comparative analysis between fornix-based and limbal-based conjunctival flaps in trabeculectomy, aiming to provide insights into success rates and complications.
Conjunctival Flaps: Fornix-based or Limbal-based: Trabeculectomy's success is intricately linked to conjunctival flap choice, either fornix-based or limbal-based. The study evaluates each approach's advantages, considerations, and objectives to guide clinicians in optimizing surgical interventions for glaucoma patients.

Materials and Methods: A prospective, non-randomized study conducted from September 2018 to August 2019 at MIMS, Vizianagaram, included 50 cases of primary glaucoma divided into Group A (limbal-based) and Group B (fornix-based). Inclusion and exclusion criteria were defined, and ethical considerations were adhered to.

Results: The study provides demographic and IOP data, indicating comparable reductions in both groups over the follow-up period. Intraoperative and post-operative complications, visual acuity changes, and bleb evaluations are presented. Group A exhibited higher complications during the post-operative period.

Conclusion: Fornix-based conjunctival flaps in trabeculectomy demonstrated advantages over limbal-based flaps in ease of fashioning, enhanced exposure, good bleb morphology, sustained IOP reduction, and decreased complications. The study contributes practical insights for ophthalmic surgeons in optimizing patient outcomes and suggests avenues for further research in trabeculectomy procedures.

Keywords: Glaucoma, Trabeculectomy, Conjunctival Flaps, Fornix-Based Flaps, Limbal-Based Flaps, IOP

INTRODUCTION

Glaucoma stands as a significant ocular pathology marked by chronic and progressive optic neuropathy. This condition is hallmarked by discernible optic nerve damage, resulting in visual field loss and an elevation in IOP [1,2]. The central aim of glaucoma treatment is the mitigation of IOP, achievable through either medical or surgical modalities. While the pharmaceutical landscape offers a variety of antiglaucoma medications [3], surgical interventions, particularly trabeculectomy, remain pivotal in the management of this condition [4,5]. The ubiquity of glaucoma, coupled with the financial constraints and healthcare dynamics of developing nations, underscores the continued importance of surgical interventions in places such as India.

Trabeculectomy, a surgical procedure pioneered by Cairns in 1968, is the most frequently employed surgical technique for glaucoma [6]. This procedure involves the creation of a new drainage pathway for aqueous humor, ultimately reducing IOP. Watson's seminal work 1970 introduced the concept of a limbus-based scleral flap, a critical innovation contributing to the evolution of filtration blebs post-trabeculectomy. These filtration blebs, indicating successful fluid drainage, have since become a hallmark in assessing the efficacy of trabeculectomy [7].

Despite advancements in pharmaceutical options, the continued prevalence of trabeculectomy reflects its enduring significance in managing glaucoma, especially in regions where access to or compliance with medications may be challenging. The evolution of surgical techniques, such as the choice between fornix-based and limbal-based conjunctival flaps, represents an ongoing endeavor to refine the procedure, enhance outcomes, and minimize complications [8].

This study contributes to this ongoing discourse by comparing fornix-based and limbal-based conjunctival flaps in trabeculectomy. By exploring success rates and complications associated with each approach, the research aims to provide insights that can guide clinicians in optimizing their surgical interventions for glaucoma patients [9].

CONJUNCTIVAL FLAPS: Fornix-based or Limbal-based

Trabeculectomy, a cornerstone in glaucoma management, involves creating a new drainage pathway to alleviate IOP. The success of this procedure is intricately linked to the choice of conjunctival flaps, specifically between fornix-based and limbal-based approaches. This study seeks to meticulously evaluate and compare the success rates associated with these 2 conjunctival flap techniques in trabeculectomy, aiming to ascertain which approach emerges as the superior choice [10].

Rationale for Conjunctival Flap Variation:

1. Fornix-based Flaps:
   Advantages: Fornix-based conjunctival flaps offer ease in surgical manipulation. They allow for a broad and direct exposure of the surgical field, facilitating meticulous dissection and construction of the filtration bleb.
   Considerations: Despite their advantages, fornix-based flaps may pose challenges in achieving uniformity, and their application demands precision in crafting to avoid complications.
2. Limbal-based Flaps:
   Advantages: The introduction of limbal-based flaps, as pioneered by Watson in 1970, has expanded the surgical options. These flaps present a technically feasible alternative, potentially minimizing certain complications associated with fornix-based approaches.
   Considerations: Limbal-based flaps necessitate careful dissection and may require additional expertise. While less direct, surgical exposure may offer unique advantages in specific clinical scenarios.

Objectives of the Study:

1. Evaluation of Success Rates:
   Assessing the post-trabeculectomy outcomes associated with fornix-based and limbal-based conjunctival flaps.

Analyzing the incidence of filtration bleb formation, its morphology, and overall success in maintaining IOP within the desired range.

2. Identification of Complications:
   Scrutinizing intraoperative and post-operative complications related to each conjunctival flap technique.
   Documenting factors such as buttonholing, tearing of Tenon's capsule, and loss of scleral flap in fornix-based flaps, and comparing them to potential complications in limbal-based flaps.
3. Long-term Follow-up:
   Investigating the sustainability of success rates over an extended period to discern any late-onset complications or shifts in outcomes.
   Monitoring for signs of bleb-related complications, visual field changes, and cataractous lens alterations.

Significance of the Study:

This comparative study seeks to contribute valuable insights into the surgical approach in trabeculectomy, with implications for clinical decision-making. The findings aim to guide ophthalmic surgeons in choosing the conjunctival flap technique that optimizes IOP control and minimizes complications, enhancing trabeculectomy procedures' overall success and safety. The knowledge gleaned from this research may influence surgical practices, further refining the armamentarium against glaucoma, a condition with substantial global impact.

MATERIALS AND METHODS

Study Design: This prospective, non-randomized study was conducted in the Department of Ophthalmology at MIMS, Vizianagaram from September 2018 to August 2019. The research focused on evaluating and comparing the outcomes of trabeculectomy with limbal-based (Group A) and fornix-based (Group B) conjunctival flaps.

Subject Selection: Fifty cases of primary glaucoma were meticulously chosen for inclusion in the study. Among them, 25 cases were assigned to Group A, which underwent trabeculectomy with limbal-based conjunctival flaps, and another 25 instances comprised Group B, where trabeculectomy was performed with fornix-based conjunctival flaps—the distribution of cases aimed to provide a balanced representation for each surgical technique.

Inclusion Criteria: Patients with primary open-angle glaucoma (POAG) or primary angle-closure glaucoma (PACG) were considered for inclusion in the study based on the following criteria:

Poor compliance with medical therapy.

Refractory to maximal medical therapy.

Presence of advanced visual field defects.

Elevated IOP at presentation.

Inability to afford the cost of antiglaucoma medications.

Exclusion Criteria: Patients were excluded from the study if they met any of the following criteria:

Congenital glaucoma.

Secondary glaucoma.

Absolute glaucoma or advanced glaucoma with doubtful perception of light (PL) - projection of rays (PR).

Ethical Considerations: The study adhered to ethical guidelines and obtained approval from the institutional review board (IRB) or ethical committee of MKCG Medical College, ensuring patient confidentiality, informed consent, and compliance with ethical standards in medical research.

Data Collection: Comprehensive preoperative evaluations, including visual acuity assessments, gonioscopy, perimetry, slit-lamp examinations, tonometry, and fundoscopy, were performed for all selected cases.

Statistical Analysis: Descriptive statistics were employed to summarize patient demographics, including age distribution and different ranges of IOP. Continuous variables, such as mean IOP in

millimetres of mercury (mm Hg), were reported with standard deviations. Categorical variables, such as complications and success rates, were presented as percentages.

RESULT

The study's design aimed to provide a robust foundation for the comparative analysis of trabeculectomy outcomes with limbal-based and fornix-based conjunctival flaps. The data collected through meticulous preoperative evaluations and post-operative assessments formed the basis for drawing meaningful conclusions regarding each surgical approach's success rates and complications.

Table 1 Comparing Glaucoma Types: PACG vs. POAG - Distribution in Groups A and B

	Group A		**Group B**	
Type of Glaucoma	No	Percentage (%)	No	Percentage (%)
PACG	11	**44**	9	**36**
POAG	14	**56**	16	**64**

Selected patients divided in 2 groups.
Group A: 25 (POAG – 14 + PACG – 11) Group B: 25 (POAG – 16 + PACG – 9)

Table 2 Distribution of Age Groups in Study Population

Age Groups (in yrs.)	**No. of Patients**	**Percentage (%)**
30 - 35	3	6
36 - 40	7	14
41 - 45	11	22
46 - 50	13	26
51 - 55	10	20
56 - 60	6	12
Total	50	100

Different Ranges of IOP:
Group A = 30.44+_7.36 mm of Hg, Group B = 30.58 +_ 7.22 mm of Hg

Table 3 Different Ranges of IOP

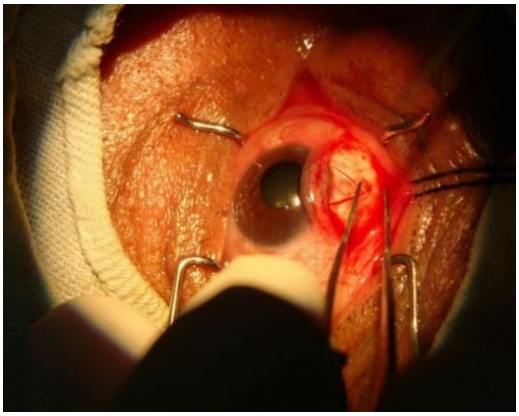
Range of IOP	No. of Eyes Group A	No of Eyes Group B	Percentage (%) Group A	Percentage (%) Group B
23.1 – 26.0	2	3	4	6
26.1 – 29.0	4	3	8	6
29.1 – 32.0	8	7	16	14
32.1 - 35.0	6	6	12	12
35.1 - 38.0	5	6	10	12
Total	25	25	50	50

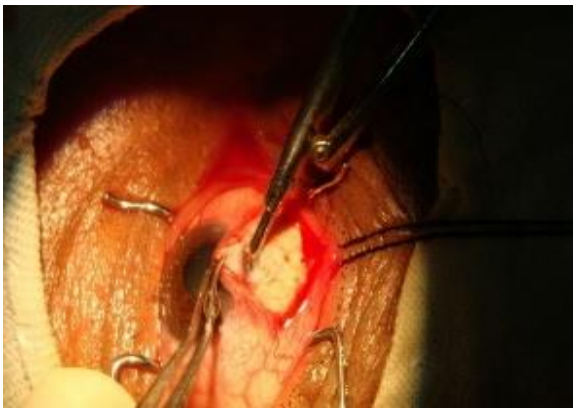
In both the groups, IOP dropped to the normal range, i.e., less than 21 mm of Hg by medical treatment before surgery.
In Group A, Limbal-based conjunctival flap.
In Group B Fornix, fornix-based conjunctival flap.

Table 4 Comparing IOP at Different Time Points: Statistical Analysis with Equal and Unequal Variance Assumptions

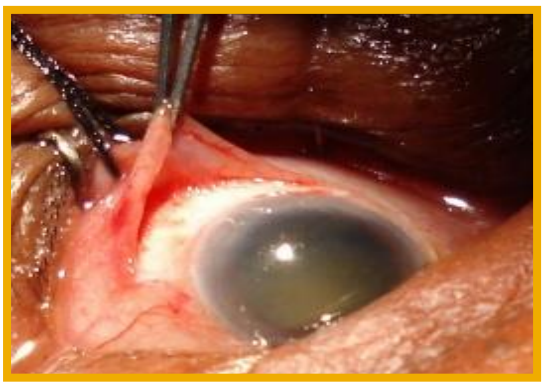
Time Point	Equal Variances Assumed	Equal Variances Not Assumed
2 Weeks IOP	t = 0.154, p = 0.878	t = 0.155, p = 0.878
6 Weeks IOP	t = 0.693, p = 0.491	t = 0.694, p = 0.490
3 Months IOP	t = 0.380, p = 0.705	t = 0.379, p = 0.706
6 Months IOP	t = 1.357, p = 0.180	t = 1.359, p = 0.179

1. **LIMBAL-BASED FLAPS**





2. **FORNIX-BASED FLAPS**



Post-Operative Examination and Complications in Trabeculectomy Analysis

The post-operative phase following trabeculectomy is crucial for evaluating the success of the treatment and monitoring any problems. This essay digs into the observations made during the post-operative examination, the occurrence of intraoperative and post-operative problems, and develops conclusions based on a comparative analysis of 2 unique groups.

Observations During Post-Op Examination:

The careful post-operative evaluation covered many criteria for assessing the patient's condition and the outcome of the trabeculectomy.

Visual Acuity: Vision changes were constantly evaluated to detect any abnormalities post-surgery.
IOP: Daily tests ensured that IOP remained within the normal range, a vital aspect in glaucoma therapy.

Bleb Evaluation: The properties of the bleb were analyzed, comprising size, shape, position, transparency, vascularity, and symptoms of leakage. These observations aid to understanding the success of the surgical operation.

Conjunctiva and Cornea Assessment: The health of the conjunctiva and cornea was checked for chemosis, congestion, haemorrhage, edema, epithelial erosion, strands, and keratic precipitates. These factors provide insights into the overall eye health and associated consequences.

Anterior Chamber (AC) and Iris Evaluation: The depth of the anterior chamber, the presence of hyphema, and any symptoms of iritis were carefully noted.

Follow-Up Schedule: An organized follow-up schedule at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively ensured systematic tracking of the patient's development and detection of any emergent concerns.

Table 5 Intraoperative Complications

Complications	Group A No.	Group A %	Group B No.	Group B %
Buttonholing of Conjunctiva	3	12	0	0
Tearing of Tenon's Capsule	1	4	0	0
Perforation of Scleral Flap	1	4	1	4
Loss of Scleral Flap	0	0	0	0
Loose Conjunctival Closure	0	0	2	8

Several problems were noticed during the trabeculectomy procedure in both Group A and Group B.
Group A: Experienced a 12% incidence of buttonholing of the conjunctiva, 4% ripping of Tenon's capsule, 4% perforation of the scleral flap, and no loss of scleral flap. Loose conjunctival closure was non-existent.
Group B: Demonstrated no buttonholing of the conjunctiva, no ripping of Tenon's capsule, a 4% incidence of perforation of the scleral flap, and no loss of the scleral flap. However, lax conjunctival closure was noted in 8% of patients.

Follow-Up of IOP:

Table 6 The follow-up regimen comprised measurements of IOP at different intervals for Group A.

Follow-Up Schedule	Mean IOP (mm Hg) ± Standard Deviation
Baseline	30.44 ± 7.36
2 Weeks	16.50 ± 4.22
6 Weeks	17.32 ± 3.58
3 Months	18.28 ± 2.42
6 Months	18.68 ± 2.23

Group A: Showed a significant reduction in mean IOP from baseline (30.44 ± 7.36 mm Hg) to 6 months postoperatively (18.68 ± 2.23 mm Hg).

Table 7 The follow-up regimen comprised measurements of IOP at different intervals for Group B.

Follow-Up Schedule	Mean IOP (mm Hg) ± Standard Deviation
Baseline	30.58 ± 7.22
2 Weeks	16.85 ± 3.22
6 Weeks	18.18 ± 4.45
3 Months	18.72 ± 2.11
6 Months	17.88 ± 3.12

Group B: Demonstrated a comparable reduction in mean IOP from baseline (30.58 ± 7.22 mm Hg) to 6 months postoperatively (17.88 ± 3.12 mm Hg).

Table 8 Early Post-Op Complications:

Complications	Group A No.	Group A %	Group B No.	Group B %
Shallow AC	7	28	5	20
Post-op Hyphaemia	2	8	1	4
Post-op Iridocyclitis	2	8	2	8
Wound Leak	1	4	3	12
Non-Filtering Bleb	2	8	3	12
Over-Draining Bleb	7	28	6	24
Subconjunctival Haemorrhage	2	8	1	4

Group A: Experienced complications such as shallow AC (28%), post-op hyphema (8%), post-op iridocyclitis (8%), wound leak (4%), non-filtering bleb (8%), over-draining bleb (28%), and subconjunctival haemorrhage (8%).

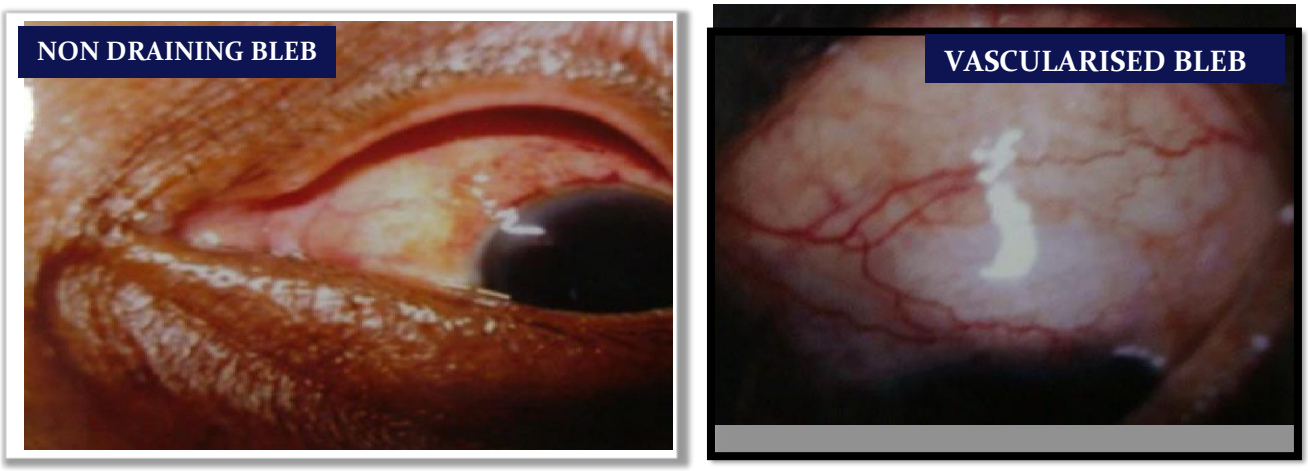


Figure 1 Complications Illustrated: Non-Draining Bleb, Vascularized Bleb,

Figure 2 Subconjunctival Haemorrhage

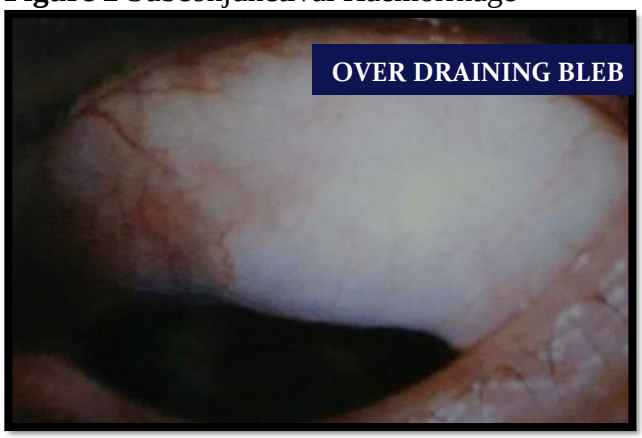


Figure 3 Over-Draining Bleb.

Group B: Encountered problems including a shallow AC (20%), post-op hyphema (4%), post-op iridocyclitis (8%), wound leak (12%), non-filtering bleb (12%), over-draining bleb (24%), and subconjunctival haemorrhage (4%).

Table 9 Late Post-Op Complications

Complications	Group A No.	Group A %	Group B No.	Group B %
Post-op Rise of IOP	3	12	2	8
Retraction of Conjunctiva	2	8	4	16
Visual Deterioration	2	8	2	8
Hypertrophy of Bleb	5	20	3	15
Encysted Bleb	1	4	0	0
Reduced Visual Field	3	12	2	8
Cataractous Changes of Lens	3	12	1	4

Group A: Presented with post-op rise of IOP (12%), retraction of conjunctiva (8%), visual deterioration (8%), hypertrophy of bleb (20%), encysted bleb (4%), limited visual field (12%), and cataractous changes of the lens (12%).
Group B: Exhibited post-op rise of IOP (8%), retraction of conjunctiva (16%), visual degeneration (8%), hypertrophy of bleb (15%), encysted bleb (0%), limited visual field (8%), and cataractous changes of the lens (4%).

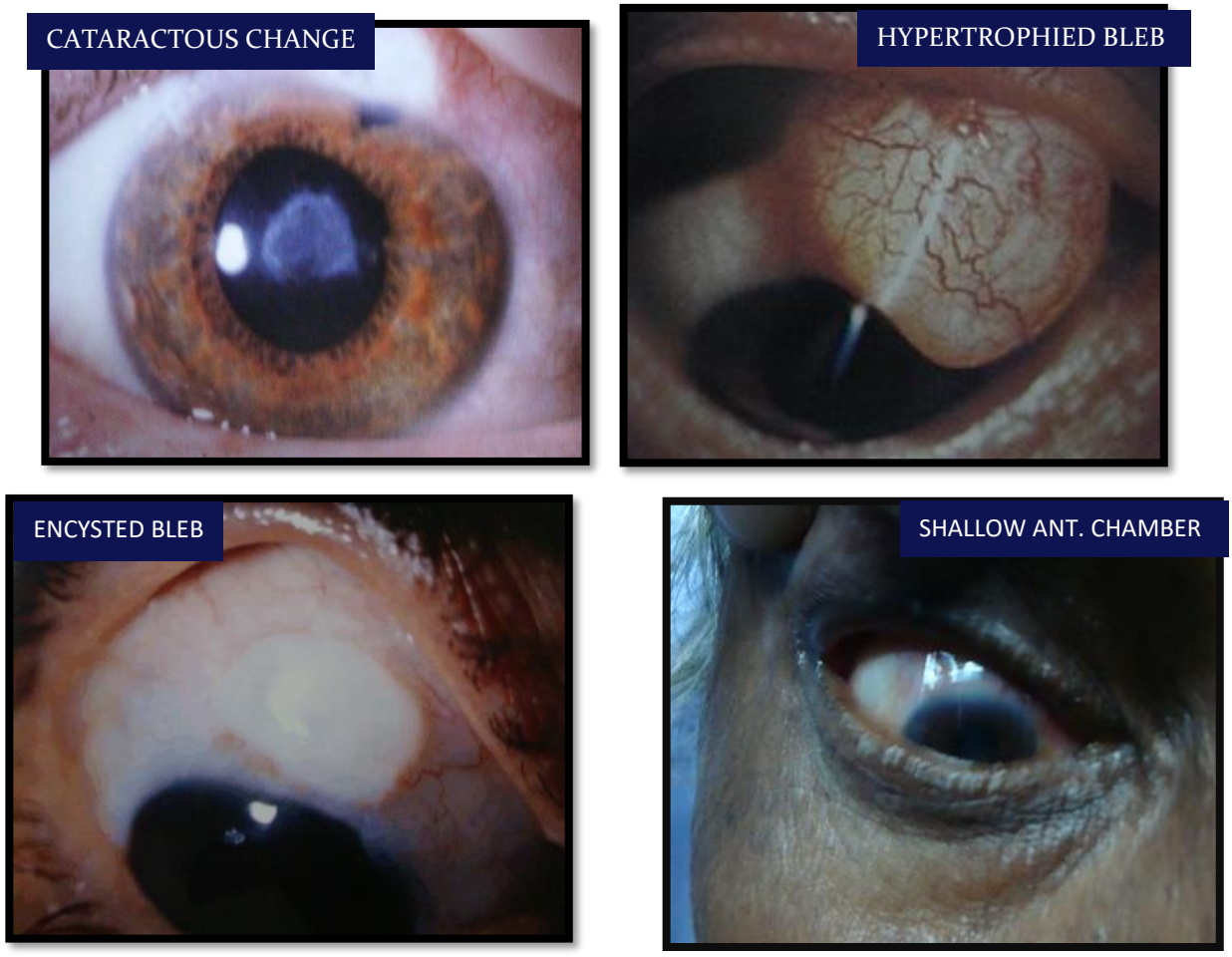


Figure 4 Cataractous change, hypertrophy of bleb, encysted bleb, and Shallow anterior chamber.

DISCUSSION

Glaucoma, a prominent cause of global blindness, is commonly managed through topical medications that reduce IOP or laser trabeculoplasty [11]. If these treatments prove ineffective, glaucoma-filtering surgery, such as trabeculectomy, is often contemplated. Surgeons may vary in their approach to performing trabeculectomy, including selecting the conjunctival flap, which can be either fornix-based or limbal-based. Several studies examine the outcomes and consequences of trabeculectomy procedures that are either fornix-based or limbal-based [12].

This research sought to evaluate the relative efficacy of fornix-based conjunctival flaps compared to limbal-based conjunctival flaps in trabeculectomy for adult glaucoma, specifically in terms of their ability to manage IOP and their rates of complications (adverse effects) [13]. The comparative study of limbal-based and fornix-based conjunctival flaps in trabeculectomy offers valuable insights into their outcomes. The study's research reveals various advantages and problems associated with each technique, influencing aspects like as ease of fashioning, exposure, bleb shape, IOP reduction, and post-operative consequences [14].

While the control of IOP appears to be better in limbal-based flaps than in fornix-based flaps, the long-term follow-up reveals that both techniques are equivalent. This discovery is relevant as IOP control is a fundamental target in glaucoma care, underscoring the efficiency of both approaches in maintaining ideal pressure levels over an extended period [15].

However, it is vital to highlight that problems in limbal-based flaps are substantially more prevalent. The complexity of fashioning the flap and obstacles associated with exposure and the formation of cystic and hypertrophied blebs contribute to a higher incidence of complications in Group A.

In the larger context of existing literature, most trials demonstrate equal efficacy between limbal-based and fornix-based flaps. While some studies support the superiority of limbal-based flaps, others indicate fornix-based flaps as the preferred option. This variety in findings underlines the complexity of the surgical landscape and underscores the significance of adapting treatments to specific patient demands [16].

From the findings of this study, it is evident that fornix-based flaps hold a distinct edge over limbal-based flaps. The ease of flap fashioning, increased exposure, good bleb shape, sustained IOP reduction during follow-up, and a decreased incidence of problems make fornix-based flaps a favourable choice in trabeculectomy surgeries. The study's relevance lies in reiterating the efficacy of trabeculectomy and offering practical insights that might aid ophthalmic surgeons in selecting the most appropriate conjunctival flap technique based on the patient's features and surgical concerns.

CONCLUSION

In the comparison investigation, although the control of IOP initially appeared more significant in limbal-based flaps, long-term follow-up indicated comparability between both approaches. Notably, problems were more frequent with limbal-based flaps. This study shows that fornix-based flaps offer a definite benefit, showcasing ease of flap fashioning, enhanced exposure, good bleb morphology, sustained IOP reduction, and decreased problems. As trabeculectomy remains a crucial intervention in glaucoma care, our findings give valuable information to ocular surgeons, supporting them in making educated decisions for optimized patient outcomes. Further and more extensive studies may continue refining our understanding and approach to trabeculectomy procedures.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

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Table of Abbreviations

AC	Anterior Chamber
IOP	Intraocular pressure
IRB	Institutional review board
PACG	Primary angle-closure glaucoma
POAG	Primary open-angle glaucoma
PR	Projection of rays