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A Prospective Study to Evaluate Filtering Blebs after Trabeculectomy using Anterior Segment OCT

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Abstract

Purpose: To evaluate the morphology of filtering blebs following trabeculectomy with mitomycin C using Anterior Segment Optical Coherence Tomography (AS-OCT) at 1 month after surgery and at 6 months follow up for bleb function.

Materials and Methods: A prospective observational study was designed to include 30 eyes (25 patients) who underwent trabeculectomy with mitomycin-C (MMC) in Mcgann District Teaching Hospital, Shimoga over a period of 1 year. Post-operatively morphology of bleb was examined at 1 month and 6 months using Anterior Segment Optical Coherence Tomography. Bleb wall was assessed for thickness of the bleb wall along with its morphology, hyper- or hypo-reflectivity and whether micro-cysts were present or not. Bleb function was considered to be successful when target pressure for each of the patient was attained post-operatively (for mild glaucoma, target pressure is kept as 15-17 mm Hg, for moderate glaucoma 12-15 mmHg and in severe glaucoma 10-12 mmHg) without any medications.

Results: Bleb function was successful in 21 (70%) eyes with mean IOP of 10-15 mmHg. Morphology of bleb on AS-OCT at one month showed uniform bleb wall reflectivity in 8 eyes (26.66%) and multiform wall reflectivity in 22 eyes (73.33%). In eyes showing multiform wall reflectivity, bleb morphology pattern of microcysts with multiple layers was seen in 10 eyes (45.45%), microcysts with subconjunctival separation in 8 eyes (36.36%) and only microcyst pattern in 4 eyes (18.18%).

When the bleb features at one month were compared with the bleb function at six months, according to the statistical analysis, blebs with the morphology of multiform wall reflectivity with many microcysts were associated with higher chances of success.

Conclusions: AS-OCT can be a predictor to assess long term functioning of filtering blebs. The filtering bleb morphology with multiform reflectivity and multiple cavities with microcysts was associated with a good functioning bleb at late post-operative period.

Keywords: Trabeculectomy; AS-OCT; Filtering Blebs; Glaucoma; Grading system.

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INTRODUCTION

Glaucoma accounts for 12.8% of preventable blindness in the country. It is the third most common cause of blindness in India.

Glaucoma is commonly diagnosed and treated by all ophthalmologists and not just the glaucoma specialists. Currently, decreasing the Intraocular pressure (which is a modifiable risk factor) is the only therapy available to treat glaucoma.[1]

Maintaining Target iop is important for reduction in progression of glaucoma. This is based on severity of glaucomatous damage in an individual patient and other known risk factors.[1]

Target IOP may not be achieved in many patients even with maximum tolerated medical therapy. In such cases, Trabeculectomy is the procedure of choice in significantly reducing IOP in patients of long term Primary Open Angle Glaucoma (POAG) and Primary Angle Closure Glaucoma (PACG).[1]

The outcome of trabeculectomy mainly depends on the morphology and formation of a functioning filtration bleb.[2]

Bleb morphology is an important clinical parameter to indicate the bleb function and any bleb related complications that may occur.[2] Bleb appearance is graded with the help of parameters like vascularity, bleb height, width, encystment according to the reference photographs (namely, Indiana Bleb appearance Grading Scale-IBAGS, Modified Moorfields Bleb Grading System-MBGS)[2]

The IBAGS, however, does not describe vascularity of the bleb away from the central area, and cannot describe mixed morphology blebs. Bleb morphology was characterised by using 4 parameters: thickness of bleb wall, height of the bleb, the proportion of the total bleb area that was diffusely elevated (as opposed to demarcated), and the total width of the bleb. This was designed by Wells *et al*.[6]

Anterior Segment Optical Coherence Tomography (AS-OCT) is a non-contact, rapid imaging device which uses low coherence interferometry to form cross-sectional images of anterior segment of the eye.[3]

AS-OCT is useful in showing cross-sectional images of bleb wall morphology that were previously seen from clinical examination. In general, AS-OCT can be used to appreciate qualitative characteristics such as structure of bleb, scleral flap location, patency of internal ostium, presence or absence of cystic spaces and also semi-quantitative characteristics like total bleb height, size of bleb cavity, thickness of bleb wall and scleral flap thickness.[4]

This information is important to detect signs of bleb failure, which can further be managed appropriately.

In this study, the morphological bleb features after trabeculectomy with MMC on AS-OCT will be evaluated to characterise the functioning of the filtering bleb post-operatively.

Aims & Objectives

1. To evaluate the morphology of blebs following trabeculectomy using AS-OCT at 1 month post-operatively.
2. To study the relation between bleb morphology using AS-OCT and the bleb functioning at 6 months post-operatively.

MATERIALS AND METHODS

A prospective observational study is designed to include 30 eyes (25 patients) undergoing trabeculectomy with mitomycin-C (MMC) in Mcgann District Teaching Hospital, Shimoga over a period of 1 year (May 2022-May 2023).

Our study included all patients with primary glaucoma (open angle or angle closure) which was refractory to the maximum medical treatment tolerated by the patient. Baseline IOP was considered as an average of minimum two measurements taken two weeks apart and measurement was done at different times of the day.

Exclusion criteria included patients with previous ocular surgery, secondary glaucoma and congenital glaucoma which were not included in the study.

This study is done with respect to the tenets of the declaration of Helsinki, and is approved by the Institutional Ethical Committee. Informed consent in the written format was obtained from all the patients before start of the study.

A single surgeon performed all surgeries using a standardized surgical technique. After the creation of fornix based conjunctival flap, sponge soaked Mitomycin C (MMC) in 0.02% concentration was applied under the conjunctiva for a duration of 2 minutes making sure that the soaked sponge doesn't come in contact with cut ends of conjunctival flap. A Triangular scleral flap

with partial scleral thickness was created followed by formation of a sclerostomy of 2×2mm using Kelly's punch. Closure of triangular scleral flap was doneusing 1 apical suture and 2 releasable sutures using 10-0 Nylon. Conjunctiva was then closed with 10-0 Nylon sutures.[11]

Post-operatively antibiotic and steroid drops were given in tapering dose overone and half months. The patients were the examined at one day, one week, one month and six months after the procedure.

IOP was measured using Goldmann-applanation tonometer at each visit. The patients were called at different times of the day in each follow-up day for detection of significant diurnal IOP fluctuations.[2]

All of the filtering blebs were examined under set magnification and illumination under slit lamp and graded according to Wuerzburg classification.[7]

This was followed by examination under AS-OCT for the morphology of filtering bleb.

Annexure 1: Wuerzburg classification

Parameters	Grading
Vascularity	3 – avascular
	2 – similar to adjacent conjunctiva
	1 – increased
	0 – massive
Corkscrew vessels	3 – none
	2 – in one third
	1 – in two thirds
	0 – entire bleb
Microcysts	3 – entire bleb
	2 – lateral or medial end of the flap
	1 – over scleral flap
	0 – none
Encapsulation	3 – none
	2 – in one third
	1 – in two-thirds
	0 – entire bleb

Successful blebs showed hyporeflective blebs suggesting of fluid filled cavity with microcysts. Failed blebs showed occlusion of ostium, or attachment of conjunctivo-episcleral to scleral flap to its bed along with absence of bleb wall thickening. These features are difficult to see with the slitlamp alone.[10]

Bleb walls with hyper reflectivity associated with fluid filled cavities, plenty of microcysts with patent internal ostia are associated with good filtration of aqueous humour.

Bleb function was labelled as successful only if target pressure for each patient was attained post operatively (for mild glaucoma, target pressure is kept as 15-17 mm Hg, for moderate glaucoma 12-15 mmHg and in severe glaucoma 10-12 mmHg)[1]

Statistical Analysis

In this study, the data collected was expressed on MS excel sheet and SPSS version 21 was used for data analysis with use of proportions, chi square test as required.

RESULTS

Out of 30 eyes which were included, 25 eyes had primary open angle glaucoma (83.33%), and 5 eyes had primary angle closure glaucoma (16.66%). Mean age was 60 years. This study included 20 males and 10 females.

Bleb function was successful in 21 (70%) eyes with mean IOP of 10-15 mmHg and failed bleb was seen in 9 (30%) eyes with mean IOP of 22 mmHg.

Bleb morphology features are depicted in Table 1 and 2.

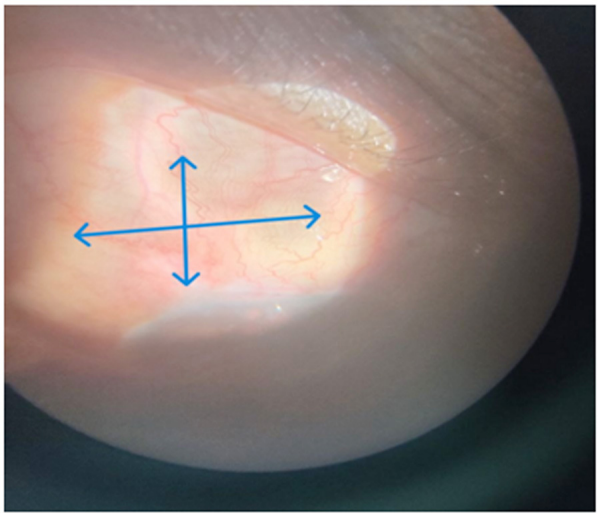

Fig. 1: Vertical and horizontal dimensions of the bleb measured in AS-OCT

Table 1: Bleb pattern at 1 month

Bleb wall morphology at 1 month	Number of eyes
Uniform bleb wall reflectivity	8 (26.66%)
Multiform wall reflectivity	22 (73.33%)

Bleb structure on AS-OCT at follow up at one month showed uniform bleb wall reflectivity in 8 eyes (26.66%) and multiform wall reflectivity in 22 eyes (73.33%).

At one month, in eyes which had multiform wall reflectivity, bleb morphology pattern of microcysts in multiple layers was shown in 10 eyes (45.45%), microcysts along with subconjunctival separation was shown in 8 eyes (36.36%) and only microcyst morphology in 4 eyes (18.18%).

When the bleb features at one month were compared with the bleb function at six months, it was found that, in the bleb wall with uniform reflectivity, only 5 out of 8 eyes (62.5%) had successful bleb function at six months and with multiform wall reflectivity, 18 out of 22 eyes (81.81%) had successful bleb function at six months (P= 0.50).

Table 2: At 1 month

Patterns in multiform wall reflectivity	Number of eyes
Multiform wall reflectivity with microcysts with multiple layers	10 (45.45%)
Microcysts with subconjunctival separation	8 (36.36%)
Only microcyst pattern	4 (18.18%)

Amongst blebs with multiform wall reflectivity, bleb pattern of microcysts with multiple layers were seen in 10 eyes. Of these, 8 eyes (80%) showed successful bleb function at post-operative period of six months.

All 8 eyes with bleb pattern of microcysts with subconjunctival separation had successful bleb function at six months (100%). Of the 4 eyes with bleb pattern of only microcysts, 3 eyes (75%) had successful bleb function at six months.

Table 3: Features of the morphology of filtering bleb on AS-OCT at 6 months after surgery

Bleb Morphology	Success (%)	Failure (%)	Total (%)
Uniform bleb	5 (62.5)	3 (37.5)	8(26.66)
Multiform wall reflectivity bleb pattern of microcysts with multiple layers	8 (80)	2 (20)	10 (45.45)
Bleb pattern of microcysts with subconjunctival separation	8 (100)	0 (0)	8 (36.36)
Bleb pattern of only microcysts	3 (75)	1 (25)	4 (18.18)

So, after six months the results showed that, Bleb walls with multiform reflectivity morphology suggested increase in success of functioning of filtering blebs at six months (P < 0.001).

Bleb walls with the morphology of multiple internal layers with microcysts also suggested increased chances of success of functioning filtering bleb at six months (P < 0.001). Hence, the bleb pattern at one month on AS-OCT is a significant predictor of surgical success at six months.

Table 4: Comparison of features of filtering bleb at 1 month and 6 months

Filtering Bleb Features on AS-OCT	At 1 Month	At 6 Months
Uniform bleb	8 eyes	5 eyes
Multiform wall reflectivity bleb pattern of microcysts with multiple layers	10 eyes	8 eyes
Bleb pattern of microcysts with subconjunctival separation	8 eyes	8 eyes
Bleb pattern of only microcysts	4 eyes	3 eyes

The logistic model achieved a high predictive accuracy of 86% and Nagelkerke

R-square was 50.4% signifies that the model has a sound explanatory power achieving P value of 0.001.

Table 5: Features of functioning vs non-functioning bleb on AS-OCT

Features of functioning bleb on AS-OCT	Features of non-functioning bleb on AS-OCT
Multiform reflectivity of bleb wall along with fluid filled multiple cavities that are seen as hypo-reflective areas suggestive of pockets of aqueous humour	Bleb walls with uniform reflectivity and flat spaces suggestive of less filtration of aqueous humour

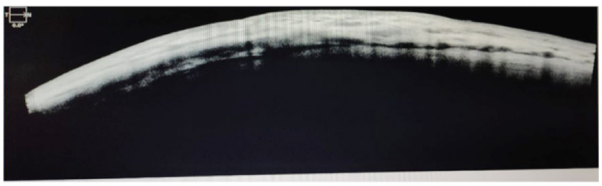

Fig. 2: AS-OCT with multiform reflectivity with microcysts

DISCUSSION

Bleb morphology is an important predictor for bleb function and success of trabeculectomy surgery.

AS-OCT has shown great efficacy in estimation of the morphology of the filtering bleb post trabeculectomy surgery.

Khamar *et al*. classified bleb wall reflectivity into two types, multiform or uniform reflectivity. Multiform bleb wall reflectivity describes a morphology with small, multiple fluid filled spaces which form the hypo-reflective areas in the conjunctiva or bleb wall. It is said that hypo-reflectivity of the bleb wall and the microcysts are

suggestive of aqueous humour collection within the filtering bleb wall. Unlike bleb walls that form uniform reflectivity at 1 month led to poor bleb function at 6 months. AS OCT is a useful tool in the early post operative period to predict the functional morphology of blebs, and hence help in early identification and intervention of Bleb failure.[2]

Mastropasqua *et al* in their study mentioned that functioning blebs, after MMC-augmented trabeculectomy, formed either a diffuse or a cystic shape. Using AS-OCT (Visante OCT), these blebs showed a patent and low reflective inner cavity with multilobed cystic shape, and a thick and low reflective bleb wall.[5]

Savini *et al* graded these filtering blebs into type A, B and C on the basis of morphology on AS-OCT. Type A blebs suggested a single elevated space under a thick layer of scarred conjunctival tissue and the fluid filled space gets extended in the horizontal meridian as well. Type B blebs showed multiple, elevated, communicating cavities beneath a thin layer of conjunctiva. Irregular septa of connective tissue of low-to-medium reflectivity could be seen beneath the bleb wall. Type C blebs featured multiple, irregular hypo-reflective flat spaces mixed with the scarred conjunctival tissue over the filtration site.[9]

Hence, Type C filtering blebs were associated with trabeculectomy with mitomycin C and good post-operative IOP control.

Singh *et al* concluded that conjunctival episcleral thickening in the bleb wall was the hallmark of blebs in which IOP was successfully controlled. This thickening reflected the flow of aqueous through conjunctivo-episclera and was better demonstrated by AS-OCT than clinical examination or photography, especially in low elevation blebs, which may be wrongly labelled as flat.[4]

In our study, we concluded that hypo-reflective blebs with microcysts and multiple fluid filled cavities had good bleb function at 1 month post-operative and 6 months post-operative.

CONCLUSIONS

The study showed that multiform wall with hypo-reflectivity with multiple internal fluid filled cavities and microcysts had chances of functioning filtering bleb at six months following trabeculectomy. Along with also affirming that AS-OCT is an important and relatively less time consuming method to estimate the success rate of trabeculectomy with respect to filtering bleb features. As AS-OCT is an objective evaluation, there is less inter-observer variability.

A limitation of this study is that there is no correlation here with the slit lamp grading and the features on AS-OCT. Also, long term follow up is required to confirm the functioning of filtration bleb in post-trabeculectomy.

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