Original Article

Analysis of Bleb Morphology After Trabeculectomy with Anterior Segment Optical Coherence Tomography


ABSTRACT

TITLE: Analysis of bleb morphology after trabeculectomy with anterior segment optical coherence tomography.

PURPOSE: To describe the use of Anterior segment optical coherence tomography (AS OCT) in imaging of trabeculectomy bleb to find out the morphology and internal structure, and correlate its internal characteristics with the function of the bleb.

METHODS: Observational case-series study. 60 eyes of 53 patients who attended glaucoma OPD during a period of March to May 2013, who had previously undergone trabeculectomy surgery/combined surgery, with a minimum postoperative period of 2 months were included. Bleb morphology was clinically noted with slit lamp. Blebs were classified as Filtering (Successful) or Nonfiltering (Failed) depending upon the IOP. Bleb was considered as Filtering bleb if last recorded IOP without any antiglaucoma medication is <18 mm Hg if the initial IOP was >18 mm Hg with or without antiglaucoma medications, 20% reduction in initial IOP if preoperative IOP was <18 mm Hg without antiglaucoma medications. Blebs were analyzed with Visante AS OCT vertical, horizontal, oblique sections for bleb wall thickness, height of internal fluid-filled cavity, suprasceral fluid space, micro cystic spaces in bleb wall, visible drainage route under the scleral flap.

RESULTS: Images were obtained of 60 blebs. 48 blebs were filtering and 12 were non-filtering. The mean preoperative IOP in filtering blebs was 24.31 ± 7.88 mm Hg, and in non filtering blebs was 17.92 ± 6.62 mm Hg. Mean postoperative IOP was 11.92 ± 3.03 mm Hg in filtering blebs and 18.25 ± 6.62 mm Hg in nonfiltering blebs. % reduction in IOP was 50 ± 26.24 % in filtering and 6.5 ± 6.76 % in non filtering blebs. AS OCT showed mean bleb wall thickness in filtering blebs is 0.70 ± 0.26 mm, and in non filtering blebs 0.44 ± 0.24 mm. Mean height of internal fluid filled cavity in filtering blebs 0.48 ± 0.29 mm, in non filtering blebs is 0.22 ± 0.22 mm. Supra-scleral fluid space was seen in 43 (90%) filtering blebs average size 0.27 ± 0.17 mm and only in 5 case of non filtering blebs, average size 0.12 ± 0.20 mm. Micro cystic spaces in the bleb wall were present in 33/48 cases of filtering blebs, with an average number being 1.46 ± 1.37 and was present in 2/12 of non filtering blebs, average number of cysts being 0.25 ± 0.62. Route under the scleral flap was present in 44 cases (92%) of filtering blebs and 6 cases (50%) in non filtering blebs.

CONCLUSION: Anterior segment optical coherence tomography (AS OCT) is a promising tool to image trabeculectomy blebs. The different patterns of intra bleb morphology identified by AS OCT were related to the bleb function. The filtering blebs exhibited a large internal fluid filled cavity, thicker bleb walls with more number of micro cysts.

Introduction

Trabeculectomy has been widely applied as treatment of choice in medically uncontrolled glaucoma patients. The outcome of this surgery depends on the formation of a functioning shunt, termed the filtration bleb, to enable egress of aqueous from the eye. Bleb morphology after trabeculectomy is an important clinical parameter; it is an indicator of bleb function.

A careful slit-lamp examination and colour photography which are non invasive, easy is important in evaluation of bleb function. Two major objective bleb grading systems, including the Indiana Bleb Appearance Grading Scale (IBAGS) and the Moorfields Bleb Grading System (MBGS) have been introduced for clinical evaluation and classification of filtering blebs. However, bleb evaluation merely based on slit-lamp examination has its own limitations; because of the subjective nature of these methods and the internal morphology of filtering blebs, which could play an important part in determining surgical outcome, cannot be evaluated under slit lamp. Ultrasound biomicroscopy, confocal microscopy, conventional retinal optical coherence tomography (OCT), and time-domain anterior segment AS OCT, are used for analyzing internal bleb characteristics. Ultrasound biomicroscopy and confocal microscopy needs...
direct contact with the eyes, conventional OCT depth of penetration is limited. More recently, anterior segment optical coherence tomography (AS-OCT) has been introduced as a useful imaging device in objective evaluation of filtering blebs. AS-OCT provides a high resolution cross-sectional optical imaging of the anterior segment structures via a noninvasive and noncontact procedure, and can provide internal visualization of the blebs.

Aim of the Study
To describe the use of anterior segment optical coherence tomography (AS OCT) in imaging of trabeculectomy bleb to find out the morphology and internal structure, and correlate its internal characteristics with the function of the bleb.

Material and Methods
This was an observational case series study study of 60 eyes of 53 patients who attended glaucoma OPD during a period of March to May 2013, who had previously undergone trabeculectomy Surgery/combined surgery, with a minimum post operative period of 2 months. Written informed consent was obtained from all patients in accordance with The tenets of Declaration of Helsinki.

Detailed evaluation of all the patients including age, sex, diagnosis and type of glaucoma, pre operative intraocular pressure, previous antiglaucoma medications, type of surgery performed, post operative period, BCVA, Gonioscopy was done.

Bleb morphology with slit lamp noted in general as diffuse, elevated, flattened.

IOP measured at the time of visit with goldmann applanation tonometry.

Blebs were classified as filtering (successfull) or non-filtering (failed) depending upon the last recorded IOP. Bleb was considered as Filtering bleb if last recorded IOP without any antiglaucoma medication is <18mm Hg if the initial IOP WAS >18mm Hg with or without antiglaucoma medications, 20% reduction in initial IOP if pre operative IOP was <18mmhg without antiglaucoma medications.

The Bleb was then imaged using a prototype of the Visante Anterior Segment – Optical Coherence Tomography (AS OCT) (Carl Zeiss Meditec Inc). The subject was asked to look down and the upper Lid gently retracted to expose the bleb as fully as possible in the Superior bulbar conjunctiva, taking care to avoid pressure on the Globe or bleb. Standard AS-OCT images were obtained for each Bleb with horizontal,vertical and oblique sections in high resolution corneal mode and the best section was used for analysis. Blebs were analyzed in terms of quantitative as well as qualitative parameters. Quantitative parameters like maximum and minimum bleb wall thickness above the fluid-filled cavity, and the maximum height of the internal fluid-filled cavity, presence or absence of micro cysts ,and number of micro cysts in the bleb wall, supra-scleral fluid space. Qualitative parameters, includes the visibility of the drainage route under scleral flap and bleb wall reflectivity. All measurements from the best possible sections were performed by the single operator.

Bleb wall thickness is defined as the distance between the first reflective signal from the conjunctiva to the top of the sub-conjunctival fluid space. As bleb wall thickness may vary along the scan, only the minimum distance was measured. The internal fluid-filled cavity was defined as a significantly low-reflective fluid-filled space adjacent to the scleral flap in millimeters, measured on the horizontal scans. Or the maximal thickness of the signal void or hyporeflective area directly beneath the bleb wall in the cross sectional image. The suprascleral fluid space was measured as the maximal vertical distance in the signal void area adjacent to the sclera. Internal reflectivity was classified as high if the reflectivity of internal structures of filtering bleb was similar to sclera, and low if the reflectivity was less than sclera.

Results
Images were obtained of 60 blebs. There were 20 (33.3%) Males and 40 (66.7%) females with a mean age of 65.13±8.87 Years. 48 were filtering and 12 were non filtering. Of 60 eyes, 41 had primary open-angle glaucoma, 14 had primary angle-closure glaucoma, and 4 pseudoexfoliation glaucoma, 1 had pigmentary glaucoma. 45 eyes had combined surgery, 8 had trabeculectomy and 7 had augmented surgery with Mitomycin C of which one was combined and 6 were trabeculectomy. The mean duration from the time of Trabeculectomy surgery to the AS OCT examination ranged from 2 months to 60 months.

Analysis done using SPSS 20 version.

Since the data is non-normal Man-Whitney test is used for analysis.

The mean preoperative IOP in filtering blebs was 24.31±7.88 mm Hg, and in non filtering blebs were 17.92±6.62 mm Hg. Mean post operative IOP was 11.92±3.03 in filtering and 18.25±6.62 in non filtering blebs. % reduction in IOP was 35±26.24 % in filtering blebs and 6.5±6.76 % in non filtering blebs.
AS OCT showed mean bleb wall thickness in filtering blebs is 0.70 ± 0.26 mm, and in non-filtering blebs 0.44 ± 0.24 mm. Mean height of internal fluid filled cavity in filtering blebs 0.48 ± 0.29 mm in, non-filtering blebs is 0.22 ± 0.22 mm. Supra scleral fluid space was seen in 43 (90%) filtering blebs average size 0.27 ± 0.17 mm and only in 5 cases of non-filtering blebs, average size 0.12 ± 0.20 m.

Micro cystic spaces in the bleb wall was present in 33/48 cases of filtering blebs, with an average number being 1.46 ± 1.37 and was present in 2/12 of non-filtering blebs, average number of cysts being 0.25 ± 0.62. Route under the sclera flap was present in 44 cases (92%) of filtering blebs and 6 cases (50%) in non-filtering blebs. The 36/44 (81%) of OAG become filtering and (13/16) 81.25% of ACG become filtering.

In our study we concluded that there is no significance in outcome between male or female, between primary open angles or primary closed angle glaucoma, and whether the surgery was combined, trabeculectomy, or augmented surgery with MMC. But the average bleb wall thickness, height of internal fluid filled cavity, number of cystic spaces and suprascleral fluid space was higher in ACG compared to OAG.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Filtering bleb</th>
<th>Non-filtering</th>
<th>P value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-operative IOP</td>
<td>24.31 ± 7.98</td>
<td>17.92 ± 7.23</td>
<td>0.009</td>
<td>Significant</td>
</tr>
<tr>
<td>Post-operative IOP</td>
<td>11.92 ± 3.03</td>
<td>18.25 ± 6.62</td>
<td>0.001</td>
<td>Significant</td>
</tr>
<tr>
<td>% Reduction in IOP</td>
<td>35.20 ± 26.24</td>
<td>6.5 ± 6.76</td>
<td>0.001</td>
<td>Significant</td>
</tr>
<tr>
<td>Bleb Wall thickness</td>
<td>0.70 ± 0.26</td>
<td>0.44 ± 0.29</td>
<td>0.009</td>
<td>Significant</td>
</tr>
<tr>
<td>Height of Int. fluid cavity</td>
<td>0.48 ± 0.29</td>
<td>0.22 ± 0.22</td>
<td>0.002</td>
<td>Significant</td>
</tr>
<tr>
<td>Number of Cystic spaces</td>
<td>1.46 ± 1.37</td>
<td>0.25 ± 0.62</td>
<td>0.002</td>
<td>Significant</td>
</tr>
<tr>
<td>Supra scleral fluid space</td>
<td>0.27 ± 0.17</td>
<td>0.12 ± 0.20</td>
<td>0.002</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Table 1: shows the various parameters measured in filtering and non-filtering blebs
It has been found that the mean pre op IOP in patients underwent augmented surgery was $32.57\pm5.86$mm Hg and with a mean reduction in IOP $46.19\pm34.47$ %, all were filtering blebs. Out of successful blebs 5 were clinically flat. Of Failed blebs 7 were flat, 2 were clinically diffuse. 3 were elevated. In elevated blebs one had iris blocking the trabeculectomy ostium, and the bleb wall intensity was high in all blebs. 2 were considered as encysted blebs.

**Discussion**

Anterior segment optical coherence tomography was useful in showing cross-sectional images of internal bleb structure that were previously inferred from clinical examination. OCT offers a better alternative for bleb imaging compared with UBM. OCT also provides higher axial resolution images (18 mm in Visante versus 25 mm in UBM) translate into more accurate and reproducible images for direct and objective bleb assessment and measurement.

In this study we observed that bleb wall thickness above the fluid-filled cavity, the maximum height of the internal fluid-filled cavity, presence or absence of micro cysts, and number of micro cysts in the bleb wall, supra-scleral fluid space, visibility of the drainage route under scleral flap and bleb wall reflectivity are good indicators of bleb function.

Filtering blebs were characterized by thick bleb wall with micro cysts on the bleb wall, with fluid filled cavity beneath the bleb and presence of suprascleral fluid space and visible drainage route under sclera flap and low reflectivity in the bleb wall. These findings were similar to the results of study done by Kelsuke Kawana et al. Filtering elevated cystic blebs were having large and multiple micro cysts on the bleb wall, with reduced wall thickness and large fluid filled area underneath. The thinner conjunctival wall in cystic blebs explains why these blebs are more prone to complications. Most of the filtering blebs were clinically diffuse. Filtering blebs which were clinically flat, on AS OCT shows average bleb wall thickness 0.51mm, height of internal fluid cavity 0.67mm. Previous studies using AS OCT by Leung CK et al. and mandeep singh et al also have demonstrated that successful blebs have thicker walls.

Non filtering blebs in general were characterized by low bleb wall thickness, small or absent internal fluid space, well apposed sclera flap characterized by absence of visible route under sclera flap,low or absent supra sclera fluid space,highly reflective bleb walls. In our study of 12 non-filtering blebs blebs 7 were clinically flat, 2 were clinically diffuse, 3 were elevated. In elevated failed blebs one had got iris blocking the trabeculectomy ostium, and the bleb wall intensity was high in all blebs. These two were considered as encysted blebs.

Imaging of the flap and ostium in the early post op period by AS-OCT may be of importance in guiding early intervention to optimize aqueous flow through the bleb. For example, laser suturelysis /release of suture is indicated in the case of a tightly apposed scleral flap.

There are a number of limitations using Visante OCT for bleb imaging. Visante OCT the software is primarily designed to image and measure anterior chamber structures. Therefore, measurements made on the bleb images may not reflect true values. Another limitation is that Visante OCT does not provide signal intensity measurements. The grading of intrableb reflectivity is essentially a subjective. This was a observational study and measurements were performed at different time points after trabeculectomy. A prospective study evaluating the time course of changes in the bleb morphologic features is required.

**Conclusion**

Anterior segment optical coherence tomography (AS OCT) is a promising tool to image trabeculectomy blebs. It was able to demonstrate features of bleb which is not visible in slit lamp. The different patterns of intra bleb morphology...
identified by AS OCT were related to the bleb function. Combining both clinical and imaging information could provide a new perspective towards understand the different surgical outcomes after trabeculectomy. The filtering blebs exhibited a large internal fluid filled cavity, thicker hyporeflective bleb walls with more number of micro cysts and a visible route under sclera flap.

REFERENCES