

Anterior-Segment Optical Coherence Tomography–Guided Measurement Of A Melting Ulcer For Follow-Up Of Corneoscleral Thinning Progression

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Purpose: To evaluate the feasibility of using anterior-segment optical coherence tomography (AS-OCT) for three-dimensional assessment of corneoscleral thinning progression in ulcers after pterygium removal.

Methods: A patient with corneoscleral melting after pterygium removal surgery and mitomycin C treatment was evaluated using AS-OCT imaging of the corneoscleral ulcer at five consecutive time points, up to 2 years. AS-OCT scans of 8.3×5.6 mm (15°×10°) containing 41 B-scans spaced 139 μm apart were performed monthly for 4 months and then at 2 years following pterygium removal. A single B-scan was comprised of 768 A-scans. Ten B-scans of the same position were averaged in a single AS-OCT image. The area of ulcer's section (AUS) was measured in seven fixed landmarks through a horizontally aligned plane in order to provide an estimation of the three-dimensional size of the lesion.

Results: The AUS in the two superior locations increased during the follow-up period to an average of 114% at 2 years compared to the initial visit. In the other five locations (three midline and two inferior), the AUS decreased and was on average 64% in the midline and 29% in the inferior locations at 24 months.

Conclusion: AS-OCT provided a readily available assessment of the lesion's three-dimensional size during repeated follow-ups and identification of localized areas at higher risk for perforation. This method may potentially be useful for corneal surface pathologies requiring repeated follow-ups and may aid in decision-making regarding corneal thickness based on an accurate measurement.

Keywords: anterior segment optical coherence tomography, corneoscleral melt, pterygium, corneoscleral thinning, ulcer follow up

Introduction

Pterygium is a fibrovascular subepithelial growth of degenerative bulbar conjunctival tissue over the limbus and cornea. One of the major complications associated with pterygium surgery and of the bare sclera resection done during the procedure, is the high incidence of recurrence that ranges from 24% to 89%.¹ Installation of mitomycin C is a well-known method to prevent these recurrences.^{2,3} Mitomycin C is a potent DNA cross-linker chemotherapeutic agent that inhibits RNA and DNA synthesis as well as fibroblast proliferation. A well-known complication of this drug is corneoscleral melts which can cause perforations and may require an urgent corneal transplantation.⁴

A corneoscleral melt creating a three-dimensional crater may need a long-term follow-up in order to assess its progression or healing process. Evaluation of the

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thickness of the remaining scleral bed is limited as the opaque scleral bed may not be visible. Therefore, a method to evaluate and measure the different dimensions of the lesion, including the lesion's depth, is needed.

Several publications have demonstrated the usefulness of anterior-segment optical coherence tomography (AS-OCT) imaging for demonstration of corneal and ocular surface pathologies including corneal and scleral melts. Abbouda et al used AS-OCT to evaluate two patients before and after performing corneal cross-linking for corneal melts following severe fungal keratitis. AS-OCT scans demonstrated changes in corneal thickness and corneal edema.⁵ Reddy et al reported the use of AS-OCT for qualitative demonstration of a scleral melt in two patients, one with Crohn's disease-associated peripheral ulcerative keratitis and another with a scleral melt associated with a remote history of beta-irradiation after pterygium resection. However, no quantification of the lesion size was performed.⁶

Other authors have used AS-OCT for the evaluation of pterygia in clinical settings. Soliman et al used AS-OCT to demonstrate pterygia and were able to demonstrate satellite masses of pterygium tissue over the cornea's stroma. They hypothesized that AS-OCT may aid with more extensive surgery and thus decrease the recurrence rate.¹ Kheirkhah et al used AS-OCT to evaluate the thickness of conjunctival graft following Pterygium surgery.⁷

To the best of our knowledge, a longitudinal quantitative assessment of the depth and area of corneoscleral melts using AS-OCT has not been reported. Corneal and scleral melts can be difficult to assess by slit-lamp examination alone, due to the three-dimensional properties of the lesion. The aim of the presented case was to demonstrate the feasibility of using readily available AS-OCT for a longitudinal quantitative semi-volumetric evaluation of corneoscleral ulcers.

Methods

Patient And Surgical Procedure

A patient with significant corneoscleral melt, 1 month after a pterygium surgery, was referred to the Goldschleger Eye Institute clinic for evaluation and treatment. The pterygium removal process included resection of the pterygium head and tenon's capsule. A sponge pre-soaked in a 0.02% mitomycin C solution was applied over the bare sclera. The surrounding conjunctiva and tenon's capsule were pulled over the sponge with forceps, and the sponge was held in contact with the sclera for 2 mins, followed by thorough washing with 50 mL of balanced saline solution. Closure of the conjunctiva was

performed by sliding a conjunctival flap from the surrounding tissue. The conjunctiva edges were approximated by suturing, leaving no bare sclera. After clinical evaluation, a decision was made to closely monitor the ulcer's progression before considering a surgical intervention.

A written informed consent was obtained from the patient for the publication of the report and the use of the images.

AS-OCT

The lesion was evaluated at 1, 2 and 4 months post-surgery and at 2 years post-surgery, using the Heidelberg Spectralis ophthalmic imaging platform (Heidelberg Engineering, Heidelberg, Germany). In addition, the patient underwent a complete bio-microscopic examination at each visit.

AS-OCT imaging was performed by the same technician at all follow-up visits, using the anterior-segment lens and the Scleral Imaging Module (Heidelberg Engineering, Heidelberg, Germany). An 8.3×5.6 mm (15°×10°) pattern was used containing 41 B-scans spaced 139 μm apart (Figure 1A). A single B-scan was comprised of a set of 768 A-scans. To improve the quality of the data and reduce noise, 10 B-scans of the same position were averaged in a single OCT image. For longitudinal progression analysis, the center of the nasal peak of the lesion (highlighted with a red line in Figure 1B) was used as a reference for the central B-scan in all visits (Figure 1B, green arrow).

In each follow-up visit, the surface area of the lesion and the area of ulcer's section (AUS) were measured. The AUS was measured in seven B-scans, two in the superior, three in the midline and two in the inferior areas of the ulcer, using the "draw region" tool in the Heidelberg Engineering software. The central B-scan [designated "Midline 2" (M2)] was set as the reference point for all follow-up analyses and for the selection of the other six B-scans for the AUS analysis (Figure 1C): The position of the Midline 1 B-scan (M1) was 139 μm superior to the reference B-scan Midline 2 (M2); B-scan Midline 3 (M3) was 139 μm inferior to the M2 scan; B-scan Superior 1 (S1) was 793 μm superior to the M2 scan; B-scan Superior 2 (S2) was 695 μm superior to the M2 scan; B-scan Inferior 1 (I1) was 695 μm inferior to the M2 scan; B-Scan Inferior 2 (I2) was 793 μm inferior to the M2 scan. In each B scan, the AUS was calculated using the "draw region" tool of the software, as demonstrated in Figure 1B.

The surface area of the lesion was measured as follows: with each position mentioned above, the nasal and temporal borders were marked with a point. All the marked locations from the different sections were used to accurately outline and define the lesion's borders. The area of the shape was

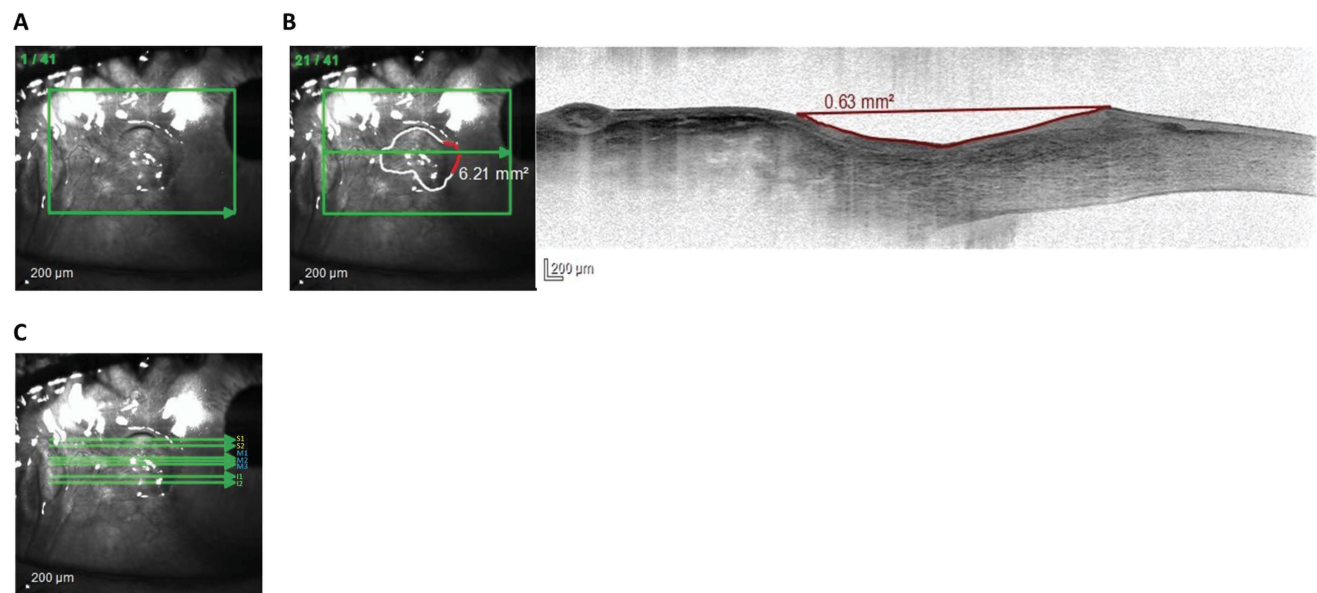


Figure 1 (A) A representative image of the corneoscleral ulcer. (B) The ulcer margins are demarcated by a white line. The surface area of the lesion was measured by the Heidelberg Spectralis software (6.21 mm²). The area demarcated by a red line was used as a reference point for the alignments of the OCT scanning and section measurements. The midline B-scan (Midline 2, M2) was selected as the center of the nasal peak of the lesion (green arrow in B). The area of ulcer's section (AUS) at this scan was 0.63 mm². (C) A schematic representation of the selected B-scans used for determination of the AUS: S1 – Superior 1, S2 – Superior 2, M1 – Midline 1, M2 – Midline 2, M3 – Midline 3, I1 – Inferior 1, I2 – Inferior 2.

measured using the Heidelberg Engineering software in mm² (Figure 1B).

Results

The ulcer's surface area at baseline was 6.58 mm². The ulcer's surface area decreased to 6.43, 6.03 and 5.8 mm² at 1, 2 and 4 months following surgery, respectively, which is a reduction of an average of ~3% per visit. At the 2-year visit, the surface area increased to 6.25 mm² (95% of the initial surface area measured).

At the most superior scan (S1), the AUS increased during follow-up, reaching 160% of baseline size by 2 years (Table 1). By contrast in the S2 scan, the AUS remained nearly constant during the first 4 months and decreased to 89% of baseline size at the 2-year visit. The midline sections

showed an initial increase of AUS at 2 months, reaching an average of 101% of baseline, but then demonstrated a constant reduction in size, reaching 57–70% of baseline size at 2 years (Table 1, M1–M3). The inferior sections showed a faster gradual reduction in AUS during follow-up visits reaching a final AUS of 23% of baseline size in the most inferior scan (I2) at 2 years post-treatment.

Discussion

To the best of our knowledge, this case demonstrates for the first time a quantitative assessment of corneoscleral lesion progression using AS-OCT. AS-OCT enabled repeated measurements of the lesion's AUS and surface area for quantitative monitoring of the healing process. Repeated measurements revealed that throughout the

Table 1 Measurement Of The Area Of Ulcer's Section (AUS) In Follow-Up Visits

B-Scan	Baseline	1 Month	2 Months	4 Months	2 Years
S1	0.25	0.25 (100%)	0.35 (140%)	0.33 (132%)	0.4 (160%)
S2	0.44	0.40 (91%)	0.49 (111%)	0.47 (107%)	0.39 (89%)
M1	0.68	0.64 (94%)	0.63 (93%)	0.61 (90%)	0.39 (57%)
M2	0.67	0.71 (106%)	0.67 (100%)	0.52 (78%)	0.47 (70%)
M3	0.67	0.69 (103%)	0.62 (93%)	0.60 (90%)	0.44 (66%)
I1	0.46	0.31 (67%)	0.21 (46%)	0.13 (28%)	0.15 (33%)
I2	0.22	0.17 (77%)	0.13 (47%)	0.07 (32%)	0.05 (23%)

Notes: Data are presented in mm². Percentage of baseline measurement is shown in parentheses. The location of the B-scans is demonstrated in Figure 1C.

Abbreviations: S, superior; M, midline; I, inferior.

follow-up period, the surface area of the corneoscleral lesion became smaller. The lesion became shallower in the majority of the locations but not in all of them. The superior sections showed slower healing and even deterioration of the ulcer, whereas the inferior edge of the ulcer showed a remarkable diminished ulcer depth.

The differential healing progress of the superior vs the inferior areas may suggest that a closer follow-up should be performed, at different lesion depths and at different locations to better assess the healing of the lesion.

Our study is limited using a single patient, although with five consecutive visits, mainly due to the fact that a corneoscleral melt is an uncommon complication of pterygium removal surgeries. Hence, we are currently presenting these findings as a case report and our findings should be tested in a larger cohort in the future.

According to the initial clinical appearance of this patient, a surgical intervention was carefully considered. Our study suggests that an in-depth imaging surveillance of the AUS and surface area may allow conservative management with lubrication and patients' monitoring before a surgical intervention. In our case, AS-OCT provided a quantitative assessment of the lesion's three-dimensional size during repeated follow-ups and identification of localized areas at higher risk for perforation. This method may potentially be useful for corneoscleral surface pathologies requiring repeated follow-ups and may aid in decision-making regarding corneal thickness based on an accurate measurement.

Conclusion

AS-OCT provided a readily available semi-volumetric assessment of opaque corneoscleral ulcer during repeated follow-ups and identification of localized areas at higher risk for perforation.

Disclosure

The authors report no conflicts of interest in this work.

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