Case Report

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Optical coherence tomography-guided early postoperative management of XEN Gel implant

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Abstract:

This interventional case series demonstrates the usefulness of anterior segment optical coherence tomography (AS-OCT) in guiding early postoperative management following XEN45 Gel Stent implantation, in conjunction with intraocular pressure (IOP) readings and slit lamp findings. Three primary open-angle glaucoma patients undergoing XEN45 Gel Stent implantation were included. Two patients received early postoperative needling because the IOP was not low enough and AS-OCT revealed that the XEN stent orifice was trapped by the Tenon's capsule. Immediately after needling, the distal tip of the XEN stent was freed and connected to a cystic space with significant IOP reduction. The third patient suffered from abrupt bleb flattening on the 5th postoperative day following XEN stent implantation. AS-OCT revealed internal occlusion of the XEN stent with exudative material, which resolved spontaneously after intensifying topical steroids with improved bleb functioning 2 days later. AS-OCT provides in-depth microscopic evaluation of the XEN stent and its relationship with surrounding tissue. This information is helpful in identifying causes of impaired outflow, determining the timing, and effect of needling intervention in eyes with inadequate bleb functioning or IOP control, especially during the early postoperative period.

Keywords:

Anterior segment optical coherence tomography, bleb needling, minimally invasive glaucoma surgery, XEN gel stent

Introduction

The XEN45 gel stent (Allergan PLC, Irvine, CA, USA) is designed to generate a bypass pathway for aqueous humor through an ab interno approach to reduce intraocular pressure (IOP) with minimal conjunctival manipulation.[1] Several reports have confirmed its efficacy and safety in decreasing IOP and use of glaucoma medications while embracing faster recovery time and less adverse effects compared with trabeculectomy.[1,2] XEN45 is a 6-mm long tube with an inner diameter of 45 μm, which creates optimal outflow by providing a steady-state pressure gradient of 6–8 mmHg along the stent to prevent intractable hypotony.[3]

The IOP following XEN stent implantation is determined by XEN stent resistance and conjunctival resistance. In the early postoperative period, due to additional peritubular flow, an ideal IOP is even lower and expected to be 3–10 mmHg.[4] However, the early postoperative IOP does not always reach the standard level; the higher it is, the higher the risk of future needling intervention and bleb failure.[5,6] We attempted to use anterior segment optical coherence tomography (AS-OCT) to evaluate the interrelationship between the XEN stent opening and surrounding soft tissue, in conjunction with IOP readings and bleb morphology, to guide further intervention to achieve the targeted low IOPs during the early postoperative period.

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Case Reports

Case 1

A 45-year-old man with primary open-angle glaucoma (POAG) with inadequate IOP control underwent XEN stent implantation in the right eye, assisted with an air-viscoelastic dissection technique [Figure 1a].[7] He experienced a shallow anterior chamber on the 1st postoperative day, which was managed with anterior chamber reformation using ophthalmic viscosurgical devices (OVDs). The IOP stabilized at 10 mmHg with a deep anterior chamber and diffuse low bleb. However, the IOP increased to 20 mmHg on the 12th postoperative day. Slit-lamp examination showed a deep anterior chamber and low bleb with transconjunctival glimmering tissue intersecting across the XEN stent opening. AS-OCT, using RTVue OCT (Optovue, Inc, Fermont, CA, USA), mounted with a cornea-lens adapter, revealed Tenon's capsule abutting the opening of the XEN stent [Figure 1b]. Therefore, needling with a 27-gauge bent needle was performed under a slit lamp to cut the tissue around the stent opening. Immediately following needling, the IOP dropped to 7 mmHg with a clear space along with the stent opening, which was clearly displayed on AS-OCT and by slit lamp [Figure 1c]. The IOP remained in the low teens with a well-functioning bleb in the following months.

Case 2

A 55-year-old man with advanced POAG underwent standard ab interno XEN stent implantation in the left eye. The preoperative IOP was approximately 18 mmHg with maximal tolerable medications. A diffuse low bleb was noted postoperatively [Figure 2a], but the IOP remained at 20 mmHg in the first 2 postoperative days, suggesting excessive interstitial resistance against the XEN stent opening. Slit-lamp examination revealed a barely visible XEN stent that appeared to be embedded in Tenon's capsule [Figure 2b], which was confirmed by AS-OCT [Figure 2c]. Guided by the stent position, its relationship, and interaction with surrounding soft tissue, needling was performed under a slit lamp, and the XEN stent was successfully freed with immediate IOP reduction to 7 mmHg [Figure 2d and e].

Case 3

A 46-year-old woman with advanced POAG and high-teens IOP readings underwent ab interno XEN stent implantation in the right eye. A diffuse bleb with a low IOP of 7 mmHg was noted on the first 2 postoperative days [Figure 3a]. On the 5th postoperative day, the bleb turned flat, localized, and congested [Figure 3b]. Strands of exudative fibrins were noticed in the anterior chamber near the corneal main wound and internal orifice of the XEN stent [Figure 3c and d]. AS-OCT revealed opaque materials occluding the inner lumen of the XEN stent adjacent to its external opening, which might be the exudative fibrins originating from the anterior chamber, as similar substances were seen surrounding the internal segment of the stent [Figure 3e and f]. With intensified topical steroids treatment, the exudation in the anterior chamber and inside the XEN stent resolved in 2 days, resulting in an elevated and functioning bleb [Figure 3g].

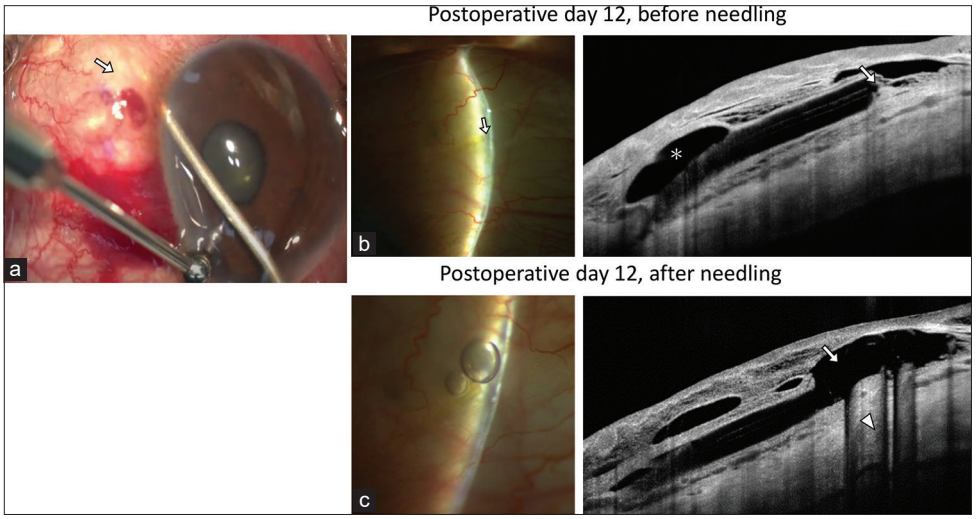

Figure 1: Microscopic evaluation of the XEN stent opening by optical coherence tomography in Case 1. (a) The air-viscoelastic dissection technique was used to assist XEN stent implantation (arrow, the subconjunctival space expanded by ophthalmic viscosurgical devices and air).(b) On postoperative day 12, the intraocular pressure was 20 mmHg. Slit-lamp examination showed a low bleb with glimmering materials ahead of the XEN stent tip in the subconjunctival space (arrow). Anterior segment optical coherence tomography revealed Tenon's capsule blocking the external orifice of the XEN stent (arrow) and some cystic spaces likely filled by the peritubular flow (asterisk). (c) Immediately after needling, the XEN stent tip was freed from the subconjunctival tissue and connected to a fluid-filled space, as revealed by slit lamp and anterior segment optical coherence tomography (arrow). Air bubbles emerged during the needling procedure (arrowhead and shadow of air bubble)

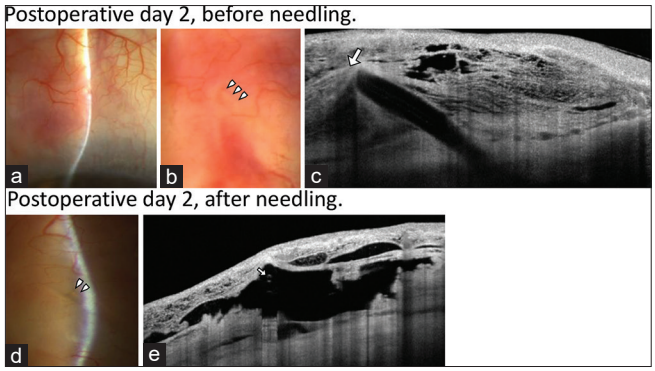

Figure 2: Needling freed the trapped XEN stent with corresponding findings in slit-lamp and optical coherence tomography in Case 2. (a) A low diffuse bleb was noted on postoperative day 2 with intraocular pressure readings at 18–20 mmHg. (b and c) The tip of XEN stent was barely seen (arrowheads) and likely to be trapped by Tenon's capsule (arrow). (d) Immediately following needling, the XEN stent was freed and became more visible (arrowheads). (e) The XEN stent tip pointed toward the superficial subconjunctival space (arrow) and was surrounded by fluid-filled spaces

Discussion

The key to achieve long-term functioning XEN stent is to start with a low IOP by minimizing the outflow resistance against external opening.[4-6] However, the relationship between the XEN stent and surrounding subconjunctival tissues can only be speculated by the mobility of XEN stent tested intraoperatively, the visibility of XEN stent, and the early postoperative IOPs.[8] The characteristic appearance of diffuse and low-lying blebs after XEN stent implantation makes it challenging to verify whether there is increasing tissue resistance around the XEN stent under a slit lamp.[8] In this case series, AS-OCT is helpful in visualizing the external orifice of XEN stent, differentiating the causes of impaired outflow, and assessing the effect of bleb needling in minimizing interstitial resistance against XEN stent opening.

Needle revision has been proved to be effective in rescuing a bleb, which dissects restricted subconjunctival tissue, sustainably reduces IOP, and restores filtration.[9,10] Timely needling is even more crucial for XEN stents, in which fibroblast proliferation may be more aggressive than trabeculectomy since minimal tissue dissection was performed and viable subconjunctival tissue was left in place.[9,10] IOP levels above 10 mmHg on the 1st postoperative day are the most pronounced predictor for future needling in stand-alone XEN stent implantation.[5] In the first two cases, tissue blocking the stent external orifice in subconjunctival space was clearly demonstrated by AS-OCT. The needling procedure was effective in reducing interstitial resistance as demonstrated by the formation of cystic fluid-filled spaces ahead of the XEN stent tip, along with immediately reduced IOPs. Szigiato *et al*. also used AS-OCT to demonstrate the effect of needling with OVDs in a fibrosed bleb, leading to a highly elevated

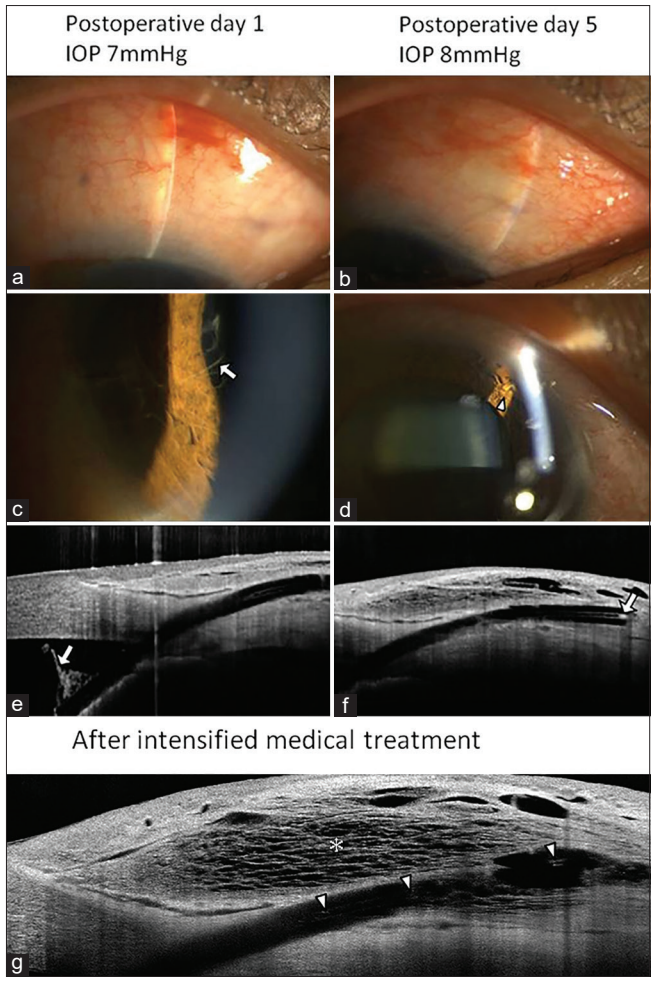

Figure 3: Internal blockage of the XEN stent by exudative fibrins in Case 3 (a) The bleb was diffuse on postoperative day 1 (b) The bleb turned to be congested and more localized on postoperative day 5. (c and d) Strands of exudative materials around the corneal wound (arrow) and internal opening of XEN stent (arrowhead) were noted. (e) anterior segment optical coherence tomography revealed exudative materials crawling along the XEN stent in the anterior chamber (arrow). (f) The internal lumen of the stent was blocked by exudative fibrins (arrow) with a low bleb. (g) Clearance of the fibrinous materials with diffuse high bleb (asterisk) and a patent external part of the XEN stent (arrowheads) was noted 2 days later. The intraocular pressure was approximately 8 mmHg in the following weeks

bleb with lowered IOP.[11] In our case series, the bleb remained functioning with fluid-filled cystic spaces for months. It remains unclear whether creating a cystic space around the XEN stent opening by needling increases the long-term success rate in these eyes with early postoperative high IOPs. Nevertheless, elevated IOP was postulated to increase the stretching of the bleb wall to activate fibroblasts with subsequent fibrosis following trabeculectomy.[12] Chao *et al*. investigating on factors predicting long-term IOP control in XEN stent also revealed that the lower the early postoperative IOP, the more likely the patients would have a functioning bleb with well-controlled IOP at 1 year.[6] Therefore, meticulous postoperative care is required to achieve a lower IOP in the early postoperative period, which is critical for long-term IOP control in XEN stent surgery.

On the other hand, AS-OCT is helpful in differentiating the causes of impaired aqueous outflow. In case 3, flattening of the bleb indicated impaired filtration, and AS-OCT showed an occluded inner lumen of the XEN stent, which guided us to wait for clearance of the exudative materials instead of performing unnecessary manipulation of the XEN stent.

In summary, AS-OCT has been utilized to understand the relationship between bleb function and structural characteristics of filtering blebs following trabeculectomy and XEN stent implantation.[11,13-15] This case series provides practical information on how to utilize AS-OCT to assist early postoperative management of XEN stent when there is inadequate IOP reduction or bleb functioning. AS-OCT is useful in guiding appropriate timing and location of needling by visualizing bleb morphology, stent location, patency, and its interaction with nearby tissues.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patients understand that his name and initial will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interests of this paper.

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