CASE REPORT

XEN-Augmented Deep Sclerectomy: Step-by-Step Description of a Novel Surgical Technique for the Management of Open-Angle Glaucoma

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ABSTRACT

Aim and background: The present case report describes a novel surgical technique combining XEN gel stent implantation and deep sclerectomy: XEN-augmented deep sclerectomy (XEN-DS).

Case description: An active 96-year-old Caucasian woman suffering from pseudoexfoliative glaucoma (PEXG) presented with intraocular pressure (IOP) of 24 mm Hg and a double arcuate visual field defect (mean deviation (MD) −9.6 dB) in her only functional eye despite maximal medical therapy. Considering (1) the magnitude of IOP reduction sought, (2) the risk of complications associated with trabeculectomies and glaucoma drainage devices, and (3) the risk of missed appointments due to the patient’s personal and social circumstances, it was decided to tailor the surgical treatment to this patient’s specific characteristics combining two existing surgical techniques. Following conjunctival dissection, a superficial scleral flap was lifted 2 mm more posteriorly than in conventional DS, and a XEN gel stent was implanted ab externo through the anterior wall of the deep sclerectomy, into the anterior chamber. A mitomycin C-soaked autologous space maintainer was used. No peri- or postoperative complications were observed. Following XEN-DS, her IOP stabilized between 5 mm Hg and 8 mm Hg through 6 months, and her visual field MD improved to −1.5 dB.

Discussion: The present case report is a proof of concept for this novel surgical technique, confirming that XEN-DS has the potential to achieve substantial and persistent IOP reductions in PEXG with a satisfactory safety profile. Clinical studies are warranted to confirm these results.

Keywords: Case report, Glaucoma, Illustrated, Intraocular pressure, Minimally-invasive glaucoma surgery, Non-penetrating, Stent, Surgery, XEN.

BACKGROUND

Glaucoma is the leading cause of irreversible blindness worldwide.¹ Intraocular pressure (IOP) reduction is the cornerstone of glaucoma management, with medical therapies and laser trabeculoplasties as the main first-line treatment options. When glaucoma progresses despite the best medical treatment, however, surgical treatment may become essential to halt disease progression.²

Described by Cairns in 1968, trabeculectomy has for many years been the gold standard of filtering surgery. However, despite robust evidence of its efficiency at lowering IOP, trabeculectomy is associated with frequent, potentially sight-threatening, postoperative complications.³ Over the years, new techniques have emerged to overcome these complications.⁴⁵ Among these, non-penetrating deep sclerectomy (DS) is regarded as an effective alternative to trabeculectomy⁶ offering similar IOP reduction with a superior safety profile.⁷ Another range of surgical techniques labeled “minimally-invasive glaucoma surgery” (MIGS) have recently gained popularity due to their relatively short recovery periods and low rates of complications. However, their IOP-lowering potentials tend to be less than that of traditional filtering surgeries, making them indicated for milder forms of glaucoma. While often considered a MIGS, XEN gel stents were shown to produce more significant IOP reduction than most minimally invasive approaches.⁸⁹ Yet, XEN gel stents are bleb-producing procedures, and as such, they are associated with frequent bleb-related complications, including a need for frequent needling revisions.¹⁰ Building on the respective strengths of DS and XEN gel stents, a new surgical technique was developed: the XEN-augmented deep sclerectomy (XEN-DS).

CASE DESCRIPTION

Case Presentation

An active 96-year-old Caucasian woman with pseudoexfoliative glaucoma (PEXG) was referred to our tertiary ophthalmology center with uncontrolled IOP despite maximum medical topical therapy, namely: prostaglandin analog, carbonic anhydrase inhibitor, beta-blocker, and alpha-adrenergic agonist topical eyedrops. She presented late due to difficulties traveling to attend medical appointments but reported good treatment compliance. She denied any family history of glaucoma. Upon examination,
Goldmann tonometry confirmed an IOP of 28 mm Hg in her right eye and 24 mm Hg in her left eye. Her best-corrected visual acuity was “counting fingers” in the right eye and 0.2 LogMAR in the left eye. Anterior segment biomicroscopic examination of the left eye demonstrated pseudophakia with pseudoxfoliative material on an atrophic pupillary sphincter and a clear cornea. Gonioscopy confirmed an open iridocorneal angle and a heavily pigmented trabecular meshwork. Fundus examination revealed a cup-to-disc ratio of 0.9 in both eyes and was otherwise unremarkable. Despite the poor visual acuity, a visual field examination was attempted, resulting in a mean deviation (MD) of $-27.6$ and $-9.6$ dB in the right and the left eye, respectively, with double arcuate defects.

**Surgical Rationale**

Based on the above clinical findings, surgical treatment was discussed, and agreed with the patient to attempt to preserve functional vision in the left eye. Considering the amplitude of IOP reduction sought, MIGS options were excluded. Yet, in presence of a monophthalmic patient with extensive visual field defects, it was also decided to avoid glaucoma drainage devices or trabeculectomies to minimize the risk of hypotony and potential wipe-out syndrome. While DS appeared to be the best-suited option, it was feared that her difficulties attending appointments may prevent adequate postoperative follow-up, including laser goniopuncture. Therefore, it was decided to perform XEN-DS to benefit from both DS’ scleral lake and XEN’s standardized outflow control.

**Surgical Protocol**

Following topical and subconjunctival anesthesia with xylocaine, blunt Westcott scissors and non-toothed Bishop-Harmon forceps were used to open the conjunctiva at the limbus. Conjunctiva and Tenon’s capsule were dissected, and a $5.5 \times 5.0$ mm superficial scleral flap was created 2 mm more posteriorly than in conventional DS (Fig. 1A), so that the dissection of the deep flap would terminate 2 mm away from the scleral spur. Corneal tissue, therefore, remained untouched. Once the deep scleral flap was excised (Fig. 1B), a scleral section was removed and soaked in mitomycin C (MMC) 0.4 mg/mL for 5 minutes. Mitomycin C-soaked sponges were applied to the deep scleral bed for 2 minutes, and the MMC-soaked scleral section was positioned perpendicular to the limbus and secured to the deep scleral bed with 10-0 Dermalon sutures. The XEN gel stent was then implanted ab externo into the anterior wall of the DS so that 1 mm lies within the anterior chamber and 3 mm rest on the deep scleral bed next to the space maintainer (Fig. 1C). The superficial flap was repositioned and secured with two 10-0 Dermalon sutures to its distal corners. The conjunctiva and Tenon’s layer were closed at the limbus with two 8-0 Safil resorbable suture (Fig. 1D). No perioperative complications were observed.

**Surgical Outcome**

Postoperatively, all anti-glaucoma medications were withdrawn and combined topical corticosteroid and antibiotic therapy (Spersadex comp, Théa PHARMA SA) was prescribed for 4 weeks. Postoperative unmedicated IOP was 5 mm Hg at day-1, and gradually increased to 8 mm Hg through to 6 months (Fig. 2). The XEN gel stent remained stable within the anterior chamber and the filtration bleb remained healthy and diffuse through to 6 months (Fig. 3). Ultrasound biomicroscopy revealed a patent intrascleral lake (Fig. 4).

No postoperative complications were observed, and no needing revision or subsequent surgical intervention was required. Interestingly, while the best-corrected visual acuity remained unchanged, visual field MD showed a marked improvement from $-9.6$ to $-1.5$ dB after 6 months (Fig. 5).

**Discussion**

This case report constitutes a proof of concept for XEN-DS, achieving significant IOP and treatment reduction without any postoperative complication, in a patient at risk of glaucoma progression and complications. The concept of XEN-DS stemmed from several observations on DS and XEN gel stents’ strengths and weaknesses.

The intrascleral space and novel intrascleral venous outflow achieved through traditional DS were shown to contribute to long-term IOP reduction. Yet, while relatively safe compared with...
trabeculectomy, DS is a challenging technique, and reported rates of accidental perforation are as high as 30%.12 These may have serious consequences such as iris incarcerations and IOP spikes13,14 or profound hypotony.12 Other groups reported hypotony in as much as 37.0% of cases.12,15 Furthermore, while postoperative follow-up is important after all glaucoma procedures, it may be even more crucial following DS.5 Indeed, after DS, most eyes experience IOP elevation due to thickening of the trabeculo-Descemet’s membrane, requiring diagnosis and laser goniopuncture.16

On the other hand, several studies confirmed XEN gel stents’ superior safety profile, with barely any reported perioperative complications,17 and low rates of postoperative hypotony.18 Furthermore, XEN gel stents were shown to produce healthier filtration blebs than filtering procedures and promote posterior fluid diffusion. This is suspected to be due to the intrinsic characteristics of the stents, the 45-μm lumen of which restricts the flow of inflammatory aqueous humor draining into the sub-conjunctival space, thus minimizing fibrosis and leading to wider-based blebs.19–23 Yet, while the IOP-reduction potential of XEN gel stents is supposedly greater than that of most MIGS, it was shown to be less than that of filtering surgeries24 and to require frequent revisions to maintain adequate filtration.10

Combining traditional DS’ intrascleral outflow with XEN gel stents’ ease of implantation, outflow control, and bleb morphologies resulted in the design of this novel technique, which seems viable and, in this specific example, achieved its aim. However, there are reports, in the literature, of specific XEN-related complications such as stent displacement or obstruction, which may affect the outcomes of this procedure. These are relatively rare and dedicated studies are warranted to confirm the efficacy and safety profile of this novel procedure.

**Conclusion**
The present case report proves the viability of XEN-DS surgery in a patient at risk of glaucoma progression and complications. No peri- or postoperative complications were observed and sustained IOP reduction was observed through to 6 months. XEN-DS might therefore be a promising novel technique in the management of moderate-to-advanced open-angle glaucoma. A longer-term study involving several patients is currently in progress.
XEN-DS: Step-by-Step Description of a Novel Surgical Technique for the Management of Open-Angle Glaucoma

REFERENCES


