

Ab-externo XEN gel stent implantation in primary open-angle glaucoma: 6-month follow-up

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Abstract

Purpose: XEN gel stent (XGS) is one of the minimally invasive glaucoma surgery (MIGS) procedures offering substantial intraocular pressure (IOP)-lowering. We evaluated the efficacy and safety of XGS implantation via an ab externo approach in patients with primary open-angle glaucoma (POAG). We present 13 cases of successful XEN implantation via an ab externo approach in these patients.

Study design: Retrospective case series.

Methods: This was a retrospective case series involving patients diagnosed with POAG at a tertiary referral centre who underwent XGS implantation between February 2019 and June 2020 for uncontrolled IOP despite maximum topical medications. All patients underwent XGS implantation via an ab externo approach placed at the superotemporal quadrant. The main outcome measure was IOP reduction and number of antiglaucoma medications after XGS implantation, post-operative procedures, and surgical complications.

Results: Thirteen eyes of 13 patients were included in the analysis. At the 6-month follow-up, mean IOP reduction was 2.73 ± 3.66 mmHg and mean IOP was 13.8 ± 1.99 mmHg on an average of 1.6 antiglaucoma medications. Complications included transient hypotony and transient IOP spikes requiring needling. Two patients required stent removal due to recurrent conjunctival erosion and stent migration into the anterior chamber.

Conclusion: XGS implantation is able to achieve good IOP control with reduced need for antiglaucoma medications after a minimum follow-up of 6 months. Longer follow-up is needed to assess its long-term outcome.

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Keywords: ab externo, minimally invasive glaucoma surgery, primary open-angle glaucoma, XEN gel stent

Implantasi gel sten XEN secara ab-externo pada pesakit glaukoma bersudut terbuka primer: lapuran pada 6 bulan rawatan susulan

Abstrak

Pengenalan: Gel sten XEN (XGS) merupakan prosedur pembedahan glaukoma invasif minima (MIGS) yang mampu menurunkan tekanan intraokular (IOP).

Objektif: Kami menilai keberkesanan dan keselamatan implantasi XEN melalui kaedah ab-externo pada pesakit glaukoma sudut terbuka primer (POAG). Kami membentangkan 13 kes implantasi XGS yang berjaya dilakukan melalui kaedah ab-externo dalam pesakit POAG

Kaedah kajian: Siri kes retrospektif yang melibatkan pesakit POAG yang telah menjalani implantasi stent gel XGS antara Februari 2019 dan Jun 2020 disebabkan oleh IOP yang tidak terkawal walaupun telah menggunakan ubat topikal secara maksimum. Semua pesakit menjalani implantasi gel sten XGS melalui kaedah ab-externo yang diletakkan di bahagian superotemporal. Kajian melihat kepada pengurangan IOP dan bilangan ubat antiglaukoma yang diperlukan selepas implantasi gel sten XGS, prosedur lain yang perlu dilakukan selepas pembedahan dan komplikasi pembedahan.

Keputusan: Tiga belas (13) pesakit yang melibatkan 13 biji mata terlibat di dalam kajian ini. Pada enam bulan, purata pengurangan IOP selepas pembedahan ialah 2.73 ± 3.66 mmHg dengan purata IOP pesakit adalah 13.8 ± 1.99 mmHg, dan purata ubat antiglaukoma ialah 1.6. Komplikasi termasuk hipotoni sementara dan lonjakan IOP sementara yang memerlukan bantuan cucukan (needling). Dua pesakit memerlukan pengeluaran sten kerana hakisan konjunktiva berulang dan penghijrahan sten ke dalam ruang anterior.

Kesimpulan dan rujukan: Implantasi gel sten XEN mampu mencapai kawalan IOP yang baik dengan pengurangan ubat antiglaukoma selepas rawatan susulan minimum 6 bulan. Kajian yang lebih lama diperlukan untuk menilai hasil jangka panjang.

Kata kunci: ab externo, bersudut terbuka primer, gel sten XEN, glaukoma pembedahan, glaukoma invasif minima

Introduction

Glaucoma is a progressive optic neuropathy causing irreversible blindness affecting more than 70 million people worldwide.¹ Intraocular pressure (IOP) is the only modifiable risk factor identified. Thus, reducing the IOP is the most effective option to slow down the progression of glaucoma.² Treatment for lowering IOP include oral and topical medications in addition to laser and surgical intervention. In open-angle glaucoma, conventional trabeculectomy, and glaucoma drainage devices are the most common procedures performed to lower IOP, but are associated with a range of complications including hypotony, leakage, choroidal effusion, and tube-related complications such as erosion, tube blockage, and bleb encapsulation.³

Minimally invasive glaucoma surgery (MIGS) is an emerging field of IOP-lowering procedures that provides fewer complications with reliable results. The XEN gel stent (XGS) is a type of MIGS which offers a good safety profile and faster recovery. In chronic open-angle glaucoma, the XEN device has been reported to provide IOP reduction of up to 56% and reduce antiglaucoma medications by up to 2.7 medications at 12 months,⁴ with a lower rate of complications compared to conventional trabeculectomy.⁵

We evaluated the outcome of XGS implant via the ab externo approach in primary open-angle glaucoma (POAG) patients with regards to IOP-lowering effect, number of needlings, and number postoperative medications, as well as complications, including stent migration and endophthalmitis.

Methods

This retrospective case series was conducted at Hospital Canselor Tuanku Muhriz (HCTM), Pusat Perubatan Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia. The study included all XGS tube implantations via ab externo approach from February 2019 to June 2020. POAG was diagnosed based on IOP elevation of ≥ 22 mmHg, open angle on gonioscopy, glaucomatous optic disc changes, and a glaucomatous reproducible visual field defect on Humphrey visual field.

Best-corrected visual acuity (BCVA), IOP, and number of glaucoma medications were recorded at baseline. A minimum of 6-months of follow-up was required for each patient to be included in the study. The BCVA, IOP, medications, postoperative procedures, complications, and management were recorded after 1 week, and 1, 3, and 6 months postoperatively.

Primary outcomes were complete success (defined as IOP ≤ 21 mmHg without additional medication) and qualified success (defined as IOP ≤ 21 mmHg, with medication).⁶ Secondary outcomes included percentage of IOP reduction, number of glaucoma medication required at 6-months postoperative, eyes achieving $> 20\%$

IOP reduction with the same or fewer number of medications without secondary surgical intervention, and postoperative complications.

Surgical technique

All XGS implantations were performed via an ab externo approach at the superotemporal quadrant. If the preoperative IOP was > 30 mmHg, slow paracentesis was performed to avoid a sudden drop in IOP and to limit the bleb size after implantation. Topical proparacaine hydrochloride 0.5% was used for anaesthesia. Corneal traction with a vicryl 7-0 suture was placed at the intended quadrant. The sites for conjunctival and scleral entry wounds were marked at 7 mm and 2.5 mm behind the limbus, respectively. Subconjunctival lidocaine hydrochloride 2% injection separated the conjunctiva from Tenon's and provided further anaesthesia. The XGS injector needle was inserted 7 mm behind the limbus with the bevel facing up, directly beneath the conjunctiva and advanced towards the scleral entry wound. While applying countertraction with the corneal traction suture, the needle pierced the sclera until the needle tip was visible in the anterior chamber (AC). The slider was then pushed until the tip of the XGS tube could be seen in the AC. The needle was slowly withdrawn while still pushing the slider to complete tube deployment. Using this technique, the ideal tube placement can be achieved, with 2 mm each in the AC, scleral tunnel, and subconjunctival space. Subconjunctival mitomycin C 0.01% (30 µg/0.3 mL) was then injected posterior to the bleb.

Postoperative management

All patients received dexamethasone 0.1% and ciprofloxacin 0.3% every two hours, and all antiglaucoma medications were discontinued. Patients were seen weekly in the first month. When required, bleb needling was performed with 5-fluorouracil (5-FU) 5 mg/0.1 mL and dexamethasone 0.4 mg/0.1 mL when there were signs of subconjunctival fibrosis or high-risk bleb failure.⁷ Steroid eyedrops were continued between 2 and 3 months postoperatively.

Needling

When needling was required postoperatively, the procedure was done in sterile conditions. Under topical proparacaine anaesthesia, a sterile 25-G needle was advanced into the subconjunctival space towards the bleb and subconjunctival and Tenon's adhesion was released. 5-FU 5% (5 mg/0.1 mL) and dexamethasone 0.4 mg/0.1mL were injected around the bleb at the end of the procedure.

Results

Thirteen eyes of 13 patients were included in this study. The mean age was 69 ± 5.3 years. There were eight males and five females. There were six patients each of

Table 1. Patient data

| Parameter | Value |
|--|---|
| Age | 69 ± 5.3 years |
| Ethnicity | 6 Malays, 6 Chinese, 1 Indian |
| Baseline IOP (mmHg) | 16.8 ± 3.2 |
| Number of antiglaucoma medications (mean ± SD) | 3.6 ± 0.6 |
| Pseudophakia (%) | 8 patients (61.5%) |
| XGS alone (%) | 10 patients (76.9%) |
| XGS with phacoemulsification (%) | 3 patients (23.1%) |
| Previous failed glaucoma procedure (%) | 2 patients (15.4%) 1 Baerveldt 1 trabeculectomy |

Malay and Chinese ethnicity, and one Indian. At baseline, eight patients were pseudophakic, while two patients had failed glaucoma drainage device procedure prior to XGS stent implantation (Table 1).

Only three of five phakic patients had combined XGS tube implantation with cataract extraction for concurrent cataract with high IOP. Their mean baseline IOP was 16.8 ± 3.2 mmHg and mean number of topical antiglaucoma medications was 3.6 ± 0.6.

All patients (100%) achieved IOP ≤ 21 mmHg. Only one patient achieved complete success, and the remaining patients achieved qualified success, requiring at least one antiglaucoma medication at 6 months postoperatively.

Effect of XGS on IOP and number of medications

At the 6-month follow-up, mean IOP was 13.8 ± 2.0 mmHg with a mean IOP reduction of 2.7 ± 3.7 mmHg, a 16.5% reduction from baseline IOP. The number of antiglaucoma medications was significantly reduced from 3.6 ± 0.6 preoperatively to 1.5 ± 0.7 at the 6-month follow-up, a mean reduction of 2.27 medications postoperatively. Five patients (45.5%) achieved more than 20% IOP reduction without requiring a secondary postoperative procedure.

Postoperative procedure

The postoperative interventions are summarized in Table 2. Postoperative procedures performed included AC reformation, XGS tube adjustment, conjunctival re-suturing, and needling. On average, all patients required 3.2 ± 1.2 needlings with 5-FU injection postoperatively. Three patients (23.1%) required AC reformation and one patient (7.7%) required XGS tube adjustment and conjunctival re-suturing due to tube migration (Table 2).

Table 2. Postoperative procedures

| Procedure | |
|--|--------------------|
| Anterior chamber reformation | 3 patients (23.1%) |
| Tube re-adjustment | 1 patient (7.7%) |
| Conjunctival re-suturing | 1 patient (7.7%) |
| Average of needling procedures per patient | 3.18 (\pm 1.19) |

Complications

The most frequent postoperative complication was transient hypotony, which occurred in four patients (30.8%) but resolved within 2 weeks. There were also transient IOP spikes of > 30 mmHg in three patients (23.1%) requiring needling upon follow-up. Additionally, two patients (15.4%) had to undergo XGS explantation due to conjunctival erosion and tube migration to the AC due to eye rubbing. None of the patients had BVCA loss or postoperative endophthalmitis at 6 months.

Discussion

MIGS aim to provide a better safety profile with less invasive IOP-reducing procedure than traditional glaucoma surgery for patients with mild-to-moderate glaucoma as well as reduce the dependency on topical medication.⁸ XGS is a porcine-based, 6-mm gelatine tube which allow aqueous drainage to the subconjunctival space through a 45 μ m lumen. This dimension is able to reduce the occurrence of postoperative hypotony by providing a steady-state pressure of 6–8 mmHg at 2.25 μ L/min flow rate.⁹ It is highly debatable whether XGS via an ab externo approach is part of MIGS, as it requires conjunctival dissection, mitomycin injection, and filtering bleb formation. To date, there are only a handful of articles in the literature discussing XGS implantation via the ab externo approach. In this retrospective study, we evaluated XGS implantation via an ab externo approach among POAG patients.

XGS were originally studied using an ab interno approach,^{5,10,11} and recent studies have shown that the ab externo approach offers greater advantages with more predictable outcomes. The ab externo approach does not require corneal incision and involves less manipulation within the AC, which makes it theoretically safer in phakic eyes.¹² Even though the ab externo approach requires conjunctival resection, it also allows surgeon to direct aqueous outflow posteriorly in a more predictable fashion with a diffuse subconjunctival bleb compared to the ab interno approach. Moreover, in experimental studies, the ab externo approach demonstrated less outflow resistance and more predictable bleb formation, providing better prospects for long-term IOP control.¹³

IOP reduction after XGS implantation ranges from 25% to 56%. Galal *et al.*¹⁴ and Perez-Terregrosa *et al.*¹⁵ reported IOP reductions of 25% and 29.34%, respectively, after 1 year of XGS implantation in POAG patients. Patients in our study had a lower mean preoperative IOP of 16.8 mmHg, thus explaining the lower percentage of IOP reduction compared to other studies. Higher baseline number of antiglaucoma medications may also contribute to poorer conjunctival condition preoperatively. Moreover, we also included two patients (15.4%) who had previous failed glaucoma surgery with higher risk of postoperative fibrosis. XGS has been shown to have comparable surgical success and complications compared to trabeculectomy up to 12 months after surgery.^{16,17}

We found transient IOP spikes that were well managed with needling postoperatively. However, we did not observe severe complications such as endophthalmitis or visual loss. Migration of the stent into the AC is possible, particularly if the patient rubs the eye, even several months postoperatively. If the XGS is implanted too superficially, stent erosion is possible and the XGS may have to be explanted.

The limitations of our study are the small number of patients and short duration of follow-up. However, the result of IOP reduction with fewer medications postoperatively provides a good predictive value for the long-term success of this approach. A longer follow-up period is required to assess long-term outcomes.

Declarations

Ethics approval and consent to participate

No ethics approval was required as this was a retrospective study.

Competing interests

None to declare.

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References

1. Tham Y-C, Li X, Wong TY, Quigley HA, Aung T, Cheng C-Y. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology*. 2014;121(11):2081–2090.

2. Heijl A, Leske MC, Bengtsson B, Hyman L, Bengtsson B, Hussein M. Reduction of intraocular pressure and glaucoma progression: results from the Early Manifest Glaucoma Trial. *Arch Ophthalmol.* 2002;120(10):1268–1279.
3. Gedde SJ, Herndon LW, Brandt JD, et al. Postoperative complications in the Tube Versus Trabeculectomy (TVT) study during five years of follow-up. *Am J Ophthalmol.* 2012;153(5):804–814.
4. Buffault J, Baudouin C, Labbé A. XEN® gel stent for management of chronic open angle glaucoma: a review of the literature. *J Fr Ophtalmol.* 2019;42(2):e37–e46.
5. Schlenker MB, Gulamhusein H, Conrad-Hengerer I, Somers A, Lenzhofner M, Stalmans I, et al. Efficacy, safety, and risk factors for failure of standalone ab interno gelatin microstent implantation versus standalone trabeculectomy. *Ophthalmology.* 2017;124(11):1579–1588.
6. Heuer DK, Barton K, Grehn F, Shaarawy T, Sherwood M. Consensus on definitions of success. In: Shaarawy T, Sherwood M, Grehn F, editors. *Guidelines on Design and Reporting of Surgical Trials.* Amsterdam, The Netherlands: Kugler Publications; 2009:15–24
7. Vera V, Sheybani A, Lindfield D, Stalmans I, Ahmed IIK. Recommendations for the management of elevated intraocular pressure due to bleb fibrosis after XEN gel stent implantation. *Clin Ophthalmol Auckl NZ.* 2019;13:685.
8. Richter GM, Coleman AL. Minimally invasive glaucoma surgery: current status and future prospects. *Clin Ophthalmol Auckl NZ.* 2016;10:189.
9. Sheybani A, Reitsamer H, Ahmed IIK. Fluid dynamics of a novel micro-fistula implant for the surgical treatment of glaucoma. *Invest Ophthalmol Vis Sci.* 2015;56(8):4789–4795.
10. Sheybani A, Dick HB, Ahmed II. Early clinical results of a novel ab interno gel stent for the surgical treatment of open-angle glaucoma. *J Glaucoma.* 2016;25(7):e691–e696.
11. Grover DS, Flynn WJ, Bashford KP, Lewis RA, Duh Y-J, Nangia RS, et al. Performance and safety of a new ab interno gelatin stent in refractory glaucoma at 12 months. *Am J Ophthalmol.* 2017;183:25–36.
12. Panarelli JF, Yan DB, Francis B, Craven ER. XEN Gel Stent Open Conjunctiva Technique: A Practical Approach Paper. *Adv Ther.* 2020;1–12.
13. Lee RM, Bouremel Y, Eames I, Brocchini S, Khaw PT. The implications of an ab interno versus ab externo surgical approach on outflow resistance of a subconjunctival drainage device for intraocular pressure control. *Transl Vis Sci Technol.* 2019;8(3):58–58.
14. Galal A, Bilgic A, Eltanamly R, Osman A. XEN Glaucoma Implant with Mitomycin C 1-Year Follow-Up: Result and Complications. *J Ophthalmol.* 2017;2017:1–5.
15. Pérez-Torregrosa VT, Olate-Pérez Á, Cerdà-Ibáñez M, et al. Combined phacoemulsification and XEN45 surgery from a temporal approach and 2 incisions. *Arch Soc Esp Oftalmol Engl Ed.* 2016;91(9):415–421.
16. Wagner FM, Schuster AK-G, Emmerich J, Chronopoulos P, Hoffmann EM. Efficacy and safety of XEN®—Implantation vs. trabeculectomy: Data of a “real-world” setting. *PLOS ONE.* 2020 Apr 20;15(4):e0231614.
17. Theilig T, Rehak M, Busch C, Bormann C, Schargus M, Unterlauff JD. Comparing the efficacy of trabeculectomy and XEN gel microstent implantation for the treatment of primary open-angle glaucoma: a retrospective monocentric comparative cohort study. *Sci Rep.* 2020 Nov 9;10(1):19337.