ORIGINAL RESEARCH

Two-year Outcomes of XEN Implantation with Minimal Bleb Needling

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Abstract

Aim: Our study aims to report the 2 years outcomes of the XEN implant in a single unit, single surgeon setting with minimal bleb needling.

Methods: A retrospective cohort study was conducted. Inclusion criteria were patients who underwent implantation with a XEN device between May 2016 and December 2017. This included patients who underwent both combined phacoemulsification and intraocular lens implantation alongside XEN implantation and those who underwent XEN implantation alone. Data gathered included basic demographic data, best-corrected visual acuity (LogMAR), intraocular pressure (IOP) in mm Hg, mean deviation from their visual field test, and the number of IOP-lowering medications they were on. This information was recorded for their preoperative visit, and then at 6, 12, 18 and 24 months postoperatively. The primary outcome assessed was a complete success when the patient was without glaucoma medications and had an IOP of 18 mm Hg or less, but more importantly, this also had to equate to a 20% reduction in IOP compared to baseline. Qualified success was defined as the same change in IOP but with medications. Surgical failure is defined as those who required additional glaucoma surgery or those who did not obtain an IOP of 18 mm Hg alongside a 20% reduction in IOP compared to baseline.

Results: At 24 months follow-up 82.5% of patients were surgical successes. Complete surgical success was achieved in 27% of patients. Qualified surgical success was achieved in 55.6% of patients. Subgroup analysis of those undergoing XEN implantation on its own and those combined with phacoemulsification + IOL were similar. The rate of bleb needling was low at 4.5%. Complication rates were acceptable at 9.5%.

Conclusion: It is possible to get good IOP control with minimal postoperative bleb needling in patients who have undergone XEN implantation. Similar success rates are found in those undergoing combined procedures.

Clinical Significance: Bleb needling carries its own risks. Minimizing the number of bleb needling allows procedures to be reserved at a later date. Furthermore, our study shows that success rates are not affected by doing a combined procedure with phacoemulsification.

Keywords: Bleb needling, Complications, Filtering surgery, MIGS, 2 years, XEN implant.

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Introduction

Glaucoma is the leading cause of irreversible blindness worldwide and it is estimated to affect 76 million people by 2020.[1] Treatment is aimed at the reduction of intraocular pressure (IOP) to prevent further visual loss.[2] This may be achieved with topical medications, laser or surgery. Since its introduction in 1968, trabeculectomy has remained the gold standard surgical technique for achieving lowered intraocular pressure (IOP).[3] Since then many attempts have been made at developing newer techniques that achieve a similar reduction in IOP whilst minimizing complications. This has led to the introduction of minimally invasive glaucoma surgeries (MIGS). These may include the introduction of a tube device one of which is the XEN implant (Allergan PLC, Irvine, CA, USA). This device allows subconjunctival filtration and has been shown to have a good safety profile with few complications.[4,5] Bleb needling has been highlighted as the most common adverse event associated with MIGS and there is minimal data examining the long-term effects of bleb needling with the XEN.[1–3] Our study reports the 2 years outcomes of the XEN implant in a single unit, single surgeon setting with minimal bleb needling. Minimal bleb needling was undertaken to avoid complications such as implant fracture, subconjunctival hemorrhage and increased subconjunctival fibrosis, all of which may lead to failure of the implant.[4] It can also be difficult to access the XEN bleb in the clinic due to its superonasal position and may require the patient to be taken to the theatre.[5]

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Materials and Methods

A retrospective analysis was conducted at East Lancashire Teaching Hospitals. Patients were found using clinical coding and review of theatre records. Inclusion criteria were patients who underwent implantation with a XEN device between May 2016 and December 2017 and completed 2 years follow-ups. This included patients who underwent both combined phacoemulsification and intraocular lens implantation alongside XEN implantation and those who underwent XEN implantation alone. To obtain the data, paper notes were reviewed initially. If paper notes were not available, electronic records were then reviewed. Data gathered included basic

demographic data (age, gender, type of glaucoma) best-corrected visual acuity (LogMAR), intraocular pressure (IOP) in mm Hg, mean deviation from their visual field test, and the number of IOP lowering medications they were on. This information was recorded for their preoperative visit, and then at 6, 12, 18 and 24 months postoperatively. Additional information recorded for postoperative visits included any complications and any further procedures that needed to be carried out. As the study was retrospective in nature and did not alter the clinical care of the patient and did not require additional information that was not otherwise recorded as part of normal clinical care ethics was not required.

As part of routine care, at each visit patients underwent best-corrected visual acuity (BCVA) with pinhole recorded with LogMAR or Snellen, slit lamp examination and measurement of intraocular pressure using Goldmann tonometry. Patients who had their visual acuity measured with Snellen had their vision converted to LogMAR using a standard conversion chart. 24-2 SITA fast Humphrey visual field was undertaken at regular intervals, usually every 6 months.

All patients underwent surgery by the same surgeon in the same unit. A corneal incision was made in the inferotemporal quadrant allowing the XEN device to be implanted into the superonasal quadrant. Subconjunctival Mitomycin C 0.1cc of 0.2 mg/mL was used to prevent inflammation and scarring. The correct position was confirmed using a gonioscopy. In patients who underwent a combined procedure of phacoemulsification and intraocular implant (phaco + IOL) and XEN implantation, the phaco and IOL were completed first, and the XEN was then implanted. Postoperatively patients were given 0.1% dexamethasone preservative-free drops to use two hourly during the day for 2 weeks, qds for 1 month and then b.d for 1 month. Preservative-free chloramphenicol 0.5% drops were also given qds for 3 weeks.

At monitoring, if IOP control was not satisfactory patients who had a satisfactorily filtering bleb with no obvious scarring or flattening were offered topical medications to help reduce their IOP. If the bleb appeared to be healing with higher than target IOP then bleb revision can be attempted.

Data were entered into a Microsoft Excel 2013 spreadsheet and statistical analysis was carried out using commercially available software (Stats direct version 3.2.4). Data were assumed to be nonparametric and Wilcoxon signed rank test was used to analyze the difference between a change in BCVA, IOP and intraocular pressure at 6,12,18 and 24 months compared to their preoperative values.

The primary outcome assessed was a complete success when the patient was without glaucoma medications and had an IOP of 18 mm Hg or less, but more importantly, this also had to equate to a 20% reduction in IOP compared to baseline. Qualified success was defined as the same change in IOP but with medications. Surgical failure is defined as those who required additional glaucoma surgery or those who did not obtain an IOP of 18 mm Hg or 20% reduction in IOP compared to baseline.

Results

Demographics

Sixty-nine patients were found to have had a XEN implant done between May 2016 and December 2017. Six were excluded as they did not complete 2 years follow-up; five passed away, one was lost to follow up. The male to female ratio was 35:28. The majority (79.4%) were found to have primary open-angle glaucoma (POAG). 11.1% had primary closed-angle glaucoma, 3.2% had ocular hypertension, 1.6% had pseudoexfoliative glaucoma and 4.7% had secondary glaucoma.

Other Pathology

Four patients had retinal pathology and were given a guarded prognosis including dry age-related macular degeneration, branch retinal vein occlusion, central retinal vein occlusion and myopic choroidal neovascularization.

Type of Procedures

Twenty-two patients had previously had a phaco + IOL implant done in the eye to be operated on. Seventeen patients had prior procedures; nine had a YAG peripheral iridotomy and nine had selective laser trabeculoplasty.

Forty patients had a combined procedure of XEN and phaco + IOL. Twenty-two patients had an XEN implant done on its own as they were already pseudophakic. One patient had an XEN implant and was phakic.

Length of Follow-up

All patients completed 2 years follow-up.

Visual Acuity

Mean visual acuity preoperatively was 0.34. A statistically significant change in visual acuity was only obtained at 6 months postoperatively. Mean visual acuity at 6 months was 0.26 (SD 0.33), 0.29 (SD 0.32) at 12 months, 0.30 (SD 0.37) at 18 months and 0.27 (SD 0.30) at 24 months.

Visual Fields

Average mean deviation preoperatively was -14.02. At 6 months postoperatively this was -12.02 (SD 8.5), at 12 months -14.33 (SD 9.9), 18 months -13.6 (SD 9.6) and at 24 months -16.6 (SD 9.1). There was no significant difference between the preoperative mean deviation and mean deviation at 6 months ($p = 0.86$), 12 months ($p = 0.46$), 18 months ($p = 0.40$) and 24 months (0.84).

Intraocular Pressures

There was a significant difference ($p < 0.001$) between preoperative IOP and IOP at 6, 12, 18 and 24 months. Change in mean IOP is shown in Figure 1. There was no significant difference in mean IOP between 6 and 12 months ($p = 0.48$), 12 and 18 months ($p = 0.87$) and 18 and 24 months ($p = 0.29$). The mean percentage reduction in IOP compared to baseline was 33.1% at 6 months, 37.6% at 12 months, 39.9 % at 18 months and 41.0% at 24 months.

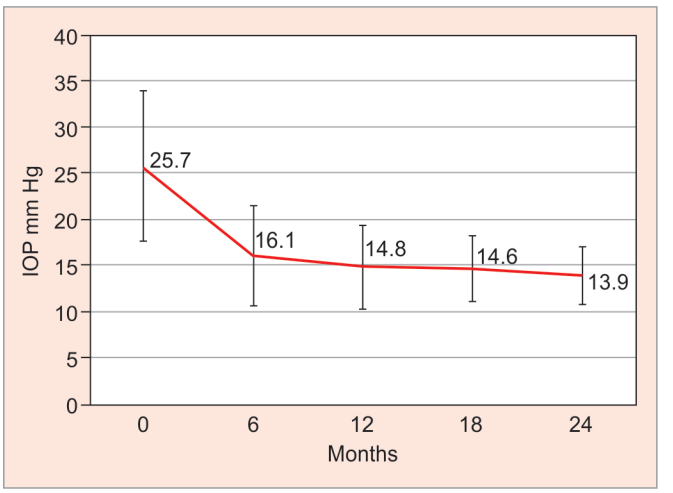

Fig. 1: Change in mean IOP over time

The percentage of patients achieving an IOP of 12 mm Hg or less, 15 mm Hg or less and 18 mm Hg or less is shown in Figure 2.

Medications

The mean number of topical medications was 2.4 preoperatively with 17 patients requiring oral acetazolamide. The mean number of medications at 6 months was 0.87, at 12 months was 1.1, at 18 months was 1.3 and at 24 months was 1.7. The number of drops required preoperatively and postoperatively are shown in Figure 3.

Complete and Qualified Surgical Success

The percentage of patients achieving complete and partial surgical success can be seen in Figure 4. What is notable is the partial surgical success increased as patients were able to obtain better IOP control after the XEN procedure and with a reduced number of topical medications.

Complete and Partial Success Rates in Phaco-XEN vs XEN on Its Own

A comparison was made between patients who underwent a combined procedure of phaco + IOL and those who underwent a XEN on its own as they were already pseudophakic. 46), at 6 months ($p = 0.87$), 12 months ($p = 0.66$), 18 months ($p = 0.64$) or 24 months ($p = 0.78$). The percentage of patients who achieved partial and complete success in the two groups can be seen in Figure 5. It can be seen that both groups achieved similar percentages or complete and partial success. The patient who underwent XEN on its own appeared to achieve a slightly higher rate of partial success at 18 months but this difference evened out at 24 months.

Further Procedures

Within the first 6 months, 3 patients required revision of bleb + 5FU and one patient required a trabeculectomy. After 12 months one further patient required bleb needling, and one patient required a re-do XEN.

Complications

Most complications occurred within 1 month of the XEN implantation. These are summarized in Table 1.

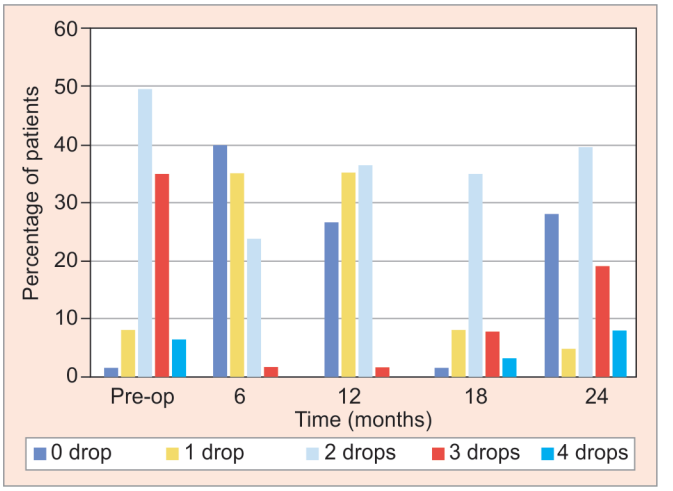

Fig. 3: Change in mean number of medications over time

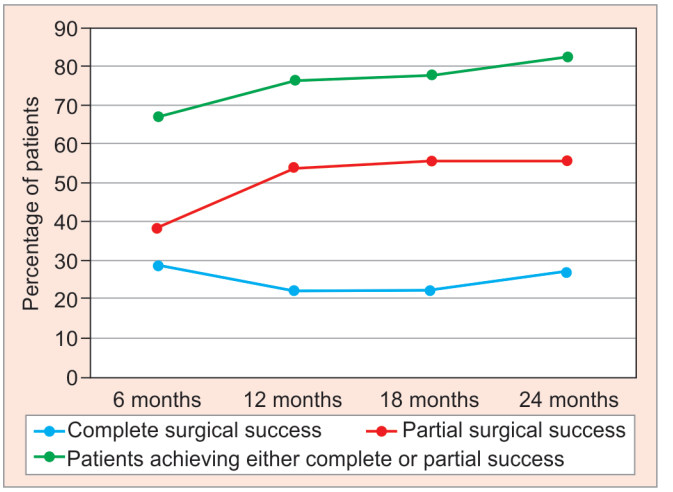

Fig. 4: Percentage of patients obtained complete success, partial success, and complete or partial success over time

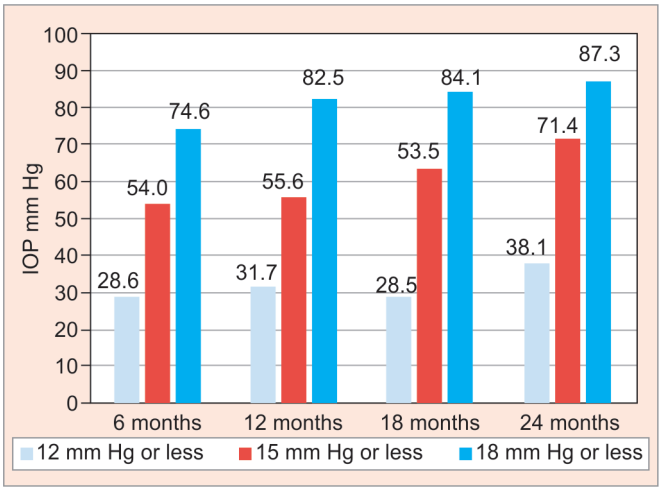

Fig. 2: Percentage of patients achieving IOP of 12 mm Hg or less, 15 mm Hg or less and 18 mm Hg or less

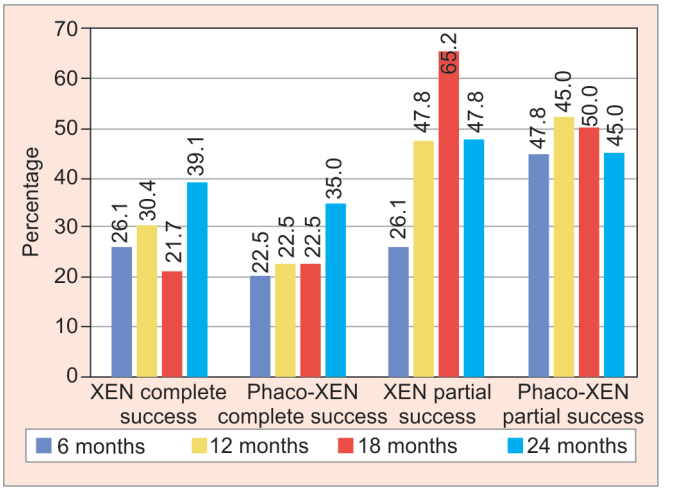

Fig. 5: Percentage of patients who achieved partial or complete success in those who underwent XEN implant only compared to those who underwent combined PhacoXEN

Failures

At 24 months 11 of the 63 patients (17.5%) were deemed to be failures; one of these patients had to undergo a trabeculectomy as their glaucoma continued to progress, the remaining 10 did not achieve an IOP of 18 mm Hg or less alongside a percentage reduction of 20% with or without medication.

Discussion

This retrospective analysis demonstrated the long-term effectiveness of the XEN in a varied real world clinical setting with minimal bleb needling. Other studies tended to have shorter follow up periods or focused on one particular diagnosis such as primary open-angle glaucoma or pseudoexfoliation glaucoma.[6–11]

The mean IOP was reduced from 25.7 mm Hg to 14.8 mm Hg at 12 months and was maintained at 13.9 mm Hg at 24 months, although at this point the majority of patients (71.4%) had recommenced medications. The mean percentage reduction in IOP at 12, 18 and 24 months was 37.6%, 39.9% and 41.0% respectively which was higher than similar studies which achieved a mean IOP reduction of 18 to 33%, at 12 months, 20.1% at 18 months and 27.9–28.2% at 24 months.[8,12–16] It appears likely that our cohort will find similar reductions at 3 years as Gillman et al. who found a mean percentage reduction ion IOP of 37% at 3 years–however they conducted a large amount of bleb needling (55.4%).[17] Interestingly Lavin-Dapena et al. completed 5 years follow-up in a small sample of patients and found a mean reduction in IOP at 5 years was 17.7%.[18] Only one of their eleven patients underwent bleb needling.

The change in the number of topical medications decreased from 2.4 at baseline to 1.1 at 12 months and 1.7 at 24 months. This is similar to other studies which had a mean number of medications at baseline ranging from 2.9-1.9, decreasing to 0.4-1.1 at 12 months, and 1.2 at 48 months.[8,12–14] Our study appears to echo a similar trajectory to the patients completing the 4 years follow-up in Lenzhofer's study despite a lower bleb needling rate.[14,10]

With regard to the visual field, we showed there was no statistical change in the visual field, showing that loss of vision was prevented which is an important outcome in the management of any glaucoma patient.

Complete success was obtained in 22.2% at 12 months and 27% at 24 months. This is lower than that found by Smith et al. at 12 months (33.8%).[14] The increase in patients obtaining complete success may be explained by those who have underwent bleb needling. Qualified success was achieved in 54% at 12 months and 55.6% at 24 months. This was slightly lower than what Smith found in their cohort which achieved the qualified success of 67.6% at 12 months. Lenzhofer had completed 4 years of follow up for XEN and used the same definition of this study and found at 4 years complete success was achieved in 25% and qualified success in 68%.[19]

If we looked solely at an IOP reduction of 20% or less with or without medications it was found that this was achieved in 84.1% at 12 months and 88.9% of patients at 24 months. This was significantly higher than a study conducted by Reitsamer et al. who found 67.6% of patients achieved an IOP reduction of 20% or less with or without medications at 12 months, with this percentage reducing slightly to 65.8% at 18 months.[12]

For those studies requiring no medications along with a 20% reduction in IOP at 12 months to be a complete success, we can see that our study achieved lower percentages in this regard at 12 months with 22.2% of patients achieving this reduction without medication compared to most other studies that achieved this between 28.0-44.5%.[10,17,20–21] It should be noted that in the study achieving complete success at 44.5% at 12 months 45% of their patients underwent bleb needling.[9]

There didn't appear to be a difference in terms of success in those undergoing XEN alone or in combination with phaco + IOL, and both forms of surgery achieved good reductions in IOP which appears to be consistent with the findings of other studies.[17,21,22,23] A meta-analysis found that although there is a significant difference 1 week postoperatively between those undergoing XEN alone versus a combined procedure after 3 months the two groups were similar.[24]

The rate of bleb needling of 4.5% was significantly lower than other reports, where rates range between 23.8-55.4%.[8,12,14,17] The lower rates of bleb needling is likely why patients required topical medications reducing complete surgical success rate but maintaining a good partial success rate. Our study demonstrates that a significant reduction in IOP can still be achieved without bleb needling but with the aid of topical medications. By keeping bleb needling at a minimum it reduces the number of procedures the patient may undergo avoiding complications such as damage to the implant[2,25] and allowing bleb needling to be kept as a secondary procedure further down the line when IOP begins to rise again.

Complication rates were acceptable at 9.5%. Although hypotony has been reported after XEN implantation and can affect up to 34.7% of patients none of the patients in our cohort had this complication.[6,13,26] We had one case of XEN erosion and this has also been reported in other studies, and it has been suggested it is due to the use of MMC or thin conjunctiva.[27]

The strengths of our study include utilizing data generated by one surgeon in one center allowing some standardization despite

Table 1: Complications and subsequent required treatment

Time of occurrence postoperatively	*Complication*	*Number of patients*	*Treatment required*
1 week	Postoperative uveitis	1	Transient and resolved with topical treatment
	Corneal edema	1	Transient and resolved with topical treatment
2 weeks	XEN erosion through conjunctiva	1	Removal of XEN and trabeculectomy 2 months postoperatively
1 month	Vitreous hemorrhage secondary to posterior vitreous detachment	1	Nil
	Cystoid macular edema	1	Transient and resolved with topical treatment
4 months	Twisted XEN implant	1	Redo XEN

the retrospective nature, and also a longer follow-up time compared to most studies. However, our study is limited due to our moderate sample size.

Conclusion

It is possible to get good IOP control with minimal postoperative bleb needling in patients who have undergone XEN implantation. Although the rates of complete success are lower than other reports, we have shown that 82.5% of patients will achieve an IOP of 18 mm Hg or lower alongside an IOP reduction of 20% or more. Furthermore, in a real-world clinical setting, a variety of patients would benefit from a XEN, with the majority of patients at 24 months having maintained a lower IOP compared to their preoperative IOP, and are on a lower number of topical medications. This in turn would mean should their IOP rise, the patient has more treatment options available to them; increase topical medications or undergo revision of their tube or another form of MIGS or trabeculectomy if required. We have also demonstrated the safety of the XEN with minimal numbers of patients requiring secondary procedures or suffering surgical failures.

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