Gonioscopy-assisted Transluminal Trabeculotomy (GATT) with Scleral or Iris Fixation for Subluxated Intraocular Lenses and Glaucoma

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Research Article

Keywords: GATT, IOL-fixation, Glaucoma, Pseudoexfoliation

Posted Date: May 31st, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1672215/v1

Abstract

Purpose – To report on a combined surgical approach of IOL fixation and GATT for the treatment of subluxated IOLs and glaucoma.

Methods – In this retrospective cohort, Charts of patients who underwent IOL-fixation combined with GATT between November 2019 and October 2021 were reviewed. Main outcome measure was surgical success, defined as a well-centered IOL and an IOP of 18mmHg or lower and either a 30% IOP reduction or a reduction in medications as compared to baseline. Complications and need for reoperation were recorded.

Results – 8 patients who underwent GATT with IOL-fixation were included. Mean age was 80.88 years (range 73-90). The pathomechanism of subluxation for all patients was pseudoexfoliation. 5 cases underwent scleral-fixation, and 3 underwent iris-fixation. Mean follow-up was 6.5 months. The success rate was 100%. Mean baseline IOP was 19.75±6.38 mmHg on 3.38±0.74 medications. 3 patients were on an oral carbonic-anhydrase inhibitor (CAI) prior to surgery. Mean IOP at the end of follow-up was 13.43±4.43 mmHg on 0.63±1.19 medications, and none were on oral CAIs. No intraoperative complications occurred, transient hyphema and vitreous hemorrhage were the most common postoperative complications. All patients had a well-centered IOL. No patients needed any additional surgery. Mean BCVA was 0.62±0.7 at baseline and 0.40±0.31 at the end of follow-up. One patient with advanced glaucoma did not recover her VA, while other patients' BCVA was either retained or improved.

Conclusions – GATT can be combined with IOL-fixation to effectively reduce IOP and medication usage.

Key Messages

- Pseudoexfoliation is a risk factor for both IOL subluxation and glaucoma. Current surgical strategies for managing IOL subluxation and glaucoma using either a step wise approach or combining IOL fixation with subconjunctival filtration have significant drawbacks.
- In this article we have shown that IOL subluxation and glaucoma can be treated simultaneously using a minimally invasive approach.
- Our finding indicate that GATT is effective in IOP and medication lowering when combined with both scleral and iris fixation.

Introduction

Intraocular lens (IOL) subluxation is a late complication of cataract surgery, whose prevalence is rising. Pseudoexfoliation (PXF) is a leading cause for IOL subluxation[1, 2] as well as a risk factor for pseudoexfoliative glaucoma (PXG), an aggressive secondary open angle glaucoma[3, 4]. When IOL subluxation and glaucoma (controlled or uncontrolled) present simultaneously, they can either be addressed separately with the more pressing issue dealt with first, or with a combined approach. IOL fixation alone in glaucoma patients has been shown to cause loss of IOP control in a significant proportion of patients[5]. Since many IOL fixation techniques involve conjunctival disruption, combination of this surgery with subconjunctival filtration surgeries is not ideal.

Gonioscopy-assisted transluminal trabeculotomy (GATT) is a minimally invasive conjunctival sparing surgical procedure in which flow is restored through the conventional pathway by cleaving the trabecular meshwork and the inner wall of Schlemm's canal. Since its original description by Grover et al[6], a significant body of evidence has accumulated demonstrating the efficacy of GATT in different types of open angle glaucomas [7–16], and specifically in PXG[17]. It has also been shown to be effective as a solo procedure as well as in combination with cataract extraction[18–20].

There are several potential advantages to combining lens fixation surgery with minimally invasive conjunctival sparing glaucoma surgery, the main ones being lowering the risk of loss of post-operative IOP control, improving IOP and medication usage, and the preservation of conjunctiva for further filtration surgeries in the future as necessary.

This study aims to describe our experience with the combination of IOL fixation surgery, both to the sclera and to the iris, with GATT.

Methods

Ethics

This retrospective study was approved by the Institutional Review Board of the Meir Medical Center which waived the need for informed consent, and adhered to the tenets of the Declaration of Helsinki.

Data gathering and patient selection

We retrospectively reviewed the medical records of all patients who underwent IOL fixation surgery combined with GATT between November 2019 and October 2021. Data collected in this study included demographic characteristics, medical history and all available clinical data from the pre-operative and post-operative visits. Intra-operative and post-operative complications were recorded, as were reoperations. Visual fields and optical coherence tomography were included if available.

Surgical technique

Scleral IOL fixation was performed using an adjustable flanged 6 – 0 polypropylene[21, 22]. Iris IOL fixation was performed using a 9 – 0 polypropylene suture with the modified McCannel technique as previously described[22, 23]. GATT was performed as previously described by Grover et al[6]. The extent of the trabeculotomy, and whether it was performed before or after the IOL fixation was at the discretion of the surgeon.

Outcomes measures

Success was defined as a clinically well centered stable IOL as well as an IOP of 18 mmHg or lower and either one of the following: a 30% IOP reduction on the same or fewer medications, or an IOP within 1 mmHg of baseline with a reduction in the number of medications. The main outcome measure was surgical success at final follow-up. Secondary outcome measures were IOP and number of medications. Intraoperative and postoperative complications were recorded, as well as the need for reoperation for IOL repositioning or IOP lowering.

Statistical analysis

In this case series, simple descriptive statistical analysis was used. Unless otherwise specified, data are presented as mean ± standard deviation (SD). Statistical analysis was performed using Excel Office 16 (Microsoft corp., United States).

Results

Eight patients who underwent GATT with IOL repositioning and fixation between November 2019 and October 2021were included in the analysis. Two surgeons (A.B, E.I.A) performed all surgeries. Mean patient age was 80.88 (range 73–90). The pathomechanism of subluxation for all patients was PXF. Four patients (50.0%) had advanced glaucoma (Cup-to-disc ration (CDR) > 0.9 or mean deviation (MD) on SITA-standard visual field lower than − 12 dB), one patient (12.5%) had moderate glaucoma (MD -9.0 dB), one patient (12.5%) had mild glaucoma (MD -4.08 dB) and one patient (12.5%) had ocular hypertension (OHT). Six cases (75.0%) underwent 6 − 0 polypropylene flange scleral fixation, and 2 (25.0%) underwent iris fixation of a three-piece foldable IOL. GATT was performed after IOL fixation in 5 patients (62.5%), and prior to it in the remaining 3. A Hemi-GATT (180 degrees) was performed in 5 patients (62.5%), and the other 3 had trabeculotomies of 200, 270 and 300 degrees. Mean follow-up was 6.3 months (range 1.2–14.27 months). The success rate at final follow up was 100.0%. Mean baseline IOP was 19.75 ± 6.38 (range 12.0 to 30.0) mmHg on 3.38 ± 0.74 medications. Three patients were on an oral carbonic-anhydrase inhibitor (CAI) prior to surgery (37.5%). Mean IOP at the end of follow up was 13.43 ± 4.43 mmHg on 0.63 ± 1.19 drops, and none were on oral CAI. There were no intraoperative complications. A transient vitreous hemorrhage was documented in 4 patients, which cleared in an average of 16 days (range 10 to 21 days). Hyphema, also transient, was observed in all patients. Four (50.0%) had a macro-hyphema, which resolved by post-operative day (POD) 32 on average (range 8 to 59 days) and 4 had micro-hyphema, which resolved by POD 20.25 on average (range 4 to 39 days). No patients needed any additional surgical interventions for IOL repositioning or for IOP control.

All patients had a centered, stable IOL at the end of the follow-up. Mean BCVA improved from 0.62 ± 0.7 logMAR to 0.40 ± 0.31 logMAR at the end of follow up. One patient with very advanced glaucoma (dark visual field prior to surgery) did not recover her baseline VA. A summary of the clinical characteristics of all patients are shown in Table 1.

Table 1
Patients' data summary.

Serial Number	Age (years)	Gender	Etiology	Glaucoma stage	IOL fixation technique	Pre-operative information				Post-operative informatior		
						BCVA (logMAR)	Maximal IOP (mmHg)	IOP (mmHg)	Number of hypotensive medications	BCVA (Final visit) (logMAR)	IOP (Final visit) (mmHg)	Number hypoten medicat (Final vi
1	77	Female	PXF	Advanced	SF	0.301	44	12	4	0.097	11	2
2	73	Male	PXF	OHT	SF	0.301	34	22	4	0.301	20	0
3	85	Male	PXF	Suspect	SF	0.699	30	30	3	0.523	9	0
4	90	Male	PXF	Advanced	IF	0.398	42	16	3	0.222	10	0
5	86	Female	PXF	Advanced	SF	0.398	26	25	4	0.523	10	3
6	82	Female	PXF	Advanced	SF	0.398	56	12	4	1.08	17	0
7	77	Male	PXF	Moderate	IF	0.151	50	18	3	0.222	17	0
8	77	Male	PXF	Mild	IF	2.3	23	23	2	0.222	14	0

BCVA – Best corrected visual acuity. IF – Iris fixation. IOL – Intraocular lens. IOP – Intraocular pressure. OHT – Ocular hypertension. PXF – Pseudoexfoliatior – Vitreous hemorrhage.

Discussion

Late IOL subluxation and increased IOP share several etiologies, chief of which is pseudoexfoliation[3]. Though IOL subluxation and lack of IOP control often co-exist[10, 11, 24, 25], they are commonly managed separately – first with addressing the IOL with repositioning or exchange, followed by IOP lowering as needed. This approach has some drawbacks, mainly loss of IOP control after the IOL surgery, even in eyes in which the IOP was previously well controlled[6, 25]. This may lead to progression of glaucomatous damage, which is particularly concerning in cases with advanced disease. If a subconjunctival filtration surgery is done as the first step in a staged approach, the functionality of the filtering bleb may be diminished when a second surgery is undertaken to fixate the IOL.

Significant advances in surgical approaches to repositioning and fixating subluxated IOLs as well as new surgical techniques for IOP control present an opportunity for combining the two in a single visit to the operating room. First, new techniques have popularized IOL fixation[21, 22, 26, 27], as a less invasive

alternative to IOL exchange.

Second, new minimally invasive glaucoma surgeries (MIGS) have shown promise in IOP reduction using ab-interno approaches. GATT has been shown to be effective in primary and secondary open angle of glaucomas[8, 9, 31, 10–12, 14, 15, 28–30], and specifically in PXG[18].

Data about combined procedures addressing both glaucoma and IOL fixation is limited. Shin et al. published the results of transscleral suture-fixated PCIOL implantation in combination with trabeculectomy in patients with glaucoma[29]. Mean IOP at final follow up was 16.7 mmHg, which is higher than the usually reported number for trabeculectomy with or without cataract extraction in studies with equivalent follow up[22], and 34% required one or more additional surgical procedures for IOP control. This suggests that the efficacy of the filtering procedure is likely diminished by this combination. It is well established that the efficacy of trabeculectomy is slightly diminished when combined with cataract extraction[23, 24]. It is likely that when combined with procedures involving exposure of the subconjunctival space such as scleral IOL-fixation this effect is more pronounced. In contrast to subconjunctival procedures, the effect of GATT does not seem to be diminished when combined with cataract surgery[17, 25, 26, 32].

Yuko Mano et. Al. published a case report showing good visual improvement with good unmedicated IOP control in a woman with a subluxated IOL and an uncontrolled IOP due to PXF who underwent a flanged scleral fixation of IOL combined with trabeculectomy[27]. Pathak-Ray et. al. recently published a series of 8 eyes which underwent flanged scleral fixated IOL combined with different glaucoma procedures (trabeculectomy, needling of pre-existing bleb and Ahmed glaucoma valve implantation) with good results. One eye in this series needed additional intervention for IOL exchange (due to IOL breakage) and later an additional procedure for IOP control[28]. None of the patients described in this series had PXF. Yusaku Miura et al. recently published results of 9 eyes which underwent flanged scleral fixated IOL combined with microhook trabeculotomy[29]. Their series demonstrated good IOL position with good IOP Control in all patients.

Success was achieved in all patients in our study, and none needed further surgery for IOL position or IOP control. The 32% reduction in IOP and 80% reduction in medication use seen in our series compares favorably with current data on GATT, suggesting the addition of IOL fixation surgery doesn't have a significant negative effect on the IOP lowering effect of this surgery. The good IOP lowering effect achieved with a conjunctival sparing approach is encouraging, because a subconjunctival filtering procedure can be performed in the future in these cases as needed as a standalone surgery with improved outcomes.

Two patients in our series lost some of their visual acuity. The first had a completely dark visual field at baseline (MD = -27.0 dB), and the other did not perform a visual field examination prior to surgery in our clinic, but had a very advanced damage with a totally cupped nerve. The vision loss is likely the result of the surgical exposure itself in eyes with very significant damage at baseline, rather than due to the specific nature of the surgery. This risk is doubled if a staged approach is chosen.

Limitations of this study include small sample size, retrospective nature, short follow up, and lack of IOL imaging and auxiliary glaucoma testing for some of the patients.

In conclusion, GATT and scleral of iris IOL fixation are well suited to be combined for the surgical treatment of increased IOP and IOL subluxation.

Declarations

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Tal Sharon and Liron Naftali Ben-Haim. The first draft of the manuscript was written by Tal Sharon and critically revised by Avner Belkin. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript

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