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Viscocanalostomy/phacoviscocanalostomy, augmented with Nd: YAG laser goniopuncture for uncontrolled intraocular pressure: 1 year results

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不同手术方式治疗眼压失控

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摘要

目的:研究黏弹物质小管切开术和超声黏弹物质小管切开术治疗眼压失控的成功率及并发症。在 Nd: YAG 前房角穿刺后,检测并发症及结果。

方法:评估 1a 内进行黏弹物质小管切开术和超声黏弹物质小管切开术时收集预期的数据。除此之外,Nd:YAG 激光房角穿孔术 (LGP)应用于术后任何时期的眼压失控。

结果:符合纳入条件并能获得随访数据者 100 眼。76%(76 眼)完全成功(未经青光眼治疗眼内压≤18mmHg),88%(88 眼)合格成功(眼内压≤18mmHg,伴或者不伴永久性青光眼的治疗)。63%(63 眼)在未用药的情况下眼内压下降了 30%,67%(67 眼)伴或者不伴有永久性青光眼的治疗。Kaplan-Meier 生存分析建议超声黏弹物质小管切开术在未用药的情况下把眼压降到 18mmHg,时序检验 $P=0.005$。16 眼在不同的时间点需要术后激光房角穿孔,大多数在术后 6mo 发作。平均眼内压术后减少 24.8%($P=0.0002$)。激光房角穿孔术后第 12mo 未经治疗的眼内压小于 18mmHg 的达到 94%(15 眼)。所有患者在激光房角穿孔术后至少 3mo 眼内压保持下降趋势,后期将继续进行随访。

结论:我们的数据显示黏弹物质小管切开术和超声黏弹物质小管切开术在这随访 1a 内能成功控制眼内压。Nd:YAG 激光房角穿孔术在降低和保持眼内压方面也很有成效。几乎没有并发症。

关键词:黏弹物质小管切开术;超声黏弹物质小管切开术;非穿透性青光眼手术;激光房角穿孔术;前房角穿刺;青光眼

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Abstract

• AIM: To evaluate the outcomes, success rate and complications encountered following viscocanalostomy and phacoviscocanalostomy. And to quantify our need, complications and results following Nd:YAG goniopuncture.

• METHODS: Data was collected prospectively on eyes undergoing viscocanalostomy or phacoviscocanalostomy and evaluation was carried out at 1 year. In addition Nd: YAG laser goniopuncture (LGP) was performed at any stage for uncontrolled post-operative IOP.

• RESULTS: Post-operative data was available for 100 eyes. Eyes achieving complete success (defined as IOP ≤ 18mmHg without any glaucoma medication) was 76% ($n=76$), and those with a qualified success (defined as a total of eyes with an IOP ≤ 18mmHg without or with 1 permanent glaucoma medications) was 88% ($n=88$). Sixty-three percent ($n=63$) of eyes achieved a 30% reduction in IOP without a need for medication and 67% ($n=67$) in total without or with 1 permanent glaucoma medication. The Kaplan-Meier survival analysis suggests phacoviscocanalostomy is superior at lowering the IOP to less than 18mmHg without medication, log rank test $P=0.005$. Sixteen eyes required post operative LGP at various time points, a majority (40%) of episodes were around 6 months post surgery. There was a 24.8% post LGP reduction in mean IOP ($P=0.0002$). For LGP at 12 months an IOP less than 18mmHg without glaucoma treatment was achieved in 94% ($n=15$) following LGP. All patients maintained a drop in IOP at least 3 months following LGP, longer follow up data was to follow.

• CONCLUSION: Our data show viscocanalostomy and phacoviscocanalostomy are highly successful at 1 year. Nd: YAG laser goniopuncture was also efficacious at lowering and maintaining the IOP. Complications were scarce.

• KEYWORDS: viscocanalostomy; phacoviscocanalostomy; non-penetrating glaucoma surgery; laser goniopuncture; goniopuncture; glaucoma

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INTRODUCTION

Glaucoma management remains a challenge. The pathophysiology responsible for optic neuropathy is still debated. It is however universally agreed that lowering the intraocular pressure retards progression of visual field loss[1,2]. Early intervention which aims to lower the intraocular pressure (IOP) remains the principal endeavour of all involved in glaucoma care.

Trabeculectomy is commonly performed for uncontrolled glaucoma; it was first described by Cairns in 1968. There are well documented complications following trabeculectomy and the post-operative care is demanding. An alternative surgical method for controlling glaucoma which is both efficacious and safe is required to completely advocate early surgical intervention. This is highlighted by the number of novel procedures that have been continuously conceived for glaucoma surgery.

Viscocanalostomy as a sole procedure presents the ability to lower the IOP without entering the anterior chamber, *i.e.* non penetrating glaucoma surgery (NPGS). The complications presented by trabeculectomy *e.g.* hypotony, shallow anterior chamber, choroidal detachment and endophthalmitis *etc.* are theoretically less frequent. With improved technique the procedure may be combined with phacoemulsification and intraocular lens (IOL) implantation for concomitant cataract (phacoviscocanalostomy). The drawback of viscocanalostomy is it demands sound surgical skill. We have found an experienced surgeon can usually master the technique easily.

Viscocanalostomy remains a novel procedure since it was described by Robert Stegmann in 1991 as a modification of deep sclerectomy. The surgical technique aims to de-roof Schlemm's canal, expose Descemet's membrane and bypass the juxtacanalicular trabecular meshwork, which is the site of highest resistance to aqueous outflow. Intubating Schlemm's canal (Canaloplasty) is a less commonly performed alternative. Deep sclerectomy is an alternative NPGS technique; unlike viscocanalostomy it does not involve dilating Schlemm's canal with a viscoelastic agent. Some surgeons have combined deep sclerectomy with phacoemulsification and have included Mitomycin C as an adjuvant[3]. Aqueous is drained through the subconjunctival bleb in deep sclerectomy and is through a dilated ostia in viscocanalostomy. In addition both procedures can also contribute to uveoscleral drainage through the base of the scleral pool[4].

In NPGS and trabeculectomy various methods are used to manipulate the post surgical site for achieving the ideal IOP. With NPGS one such method is Nd:YAG laser goniopuncture (LGP). We aim to evaluate the outcomes of viscocanalostomy and phacoviscocanalostomy in detail and to quantify our need to use Nd:YAG goniopuncture, the success rate and the complications encountered. The prospect of a safe, effective adjunctive office based treatment to achieve additional IOP reduction is both attractive and desirable.

SUBJECTS AND METHODS

Data was collected prospectively on 104 eyes undergoing viscocanalostomy or phacoviscocanalostomy, 12 month post-operative data is available. The surgery performed involved either viscocanalostomy as a sole procedure or alternatively, phacoviscocanalostomy for concomitant symptomatic cataract. The use of Nd:YAG laser goniopuncture for uncontrolled IOP after viscocanalostomy or phacoviscocanalostomy forms part of our routine management for uncontrolled POAG. No randomisation was carried out. Descriptive statistics and bivariate analysis was carried out using IBM SPSS version 19.0. Ethics was through the local research and ethics committee and the national Welsh guidelines, deeming the study a service evaluation.

Surgical Technique All procedures were performed by a single experienced surgeon (DM). The technique is similar to the descriptions in the literature[5-7]. Standard phacoemulsification and intraocular lens implantation was performed through a keratome blade incision between the superficial and deep scleral flaps. Additionally in cases of NAG, if peripheral anterior synechiae (PAS) was extensive and no seepage was seen through the trabeculo-Descemet window (TDW) during surgery, the membrane was perforated intentionally and peripheral iridectomy performed. Patients were reviewed on day 1, week 1, at 1 month, every 3 months for a year and 6 monthly thereafter, if there were no complications. Clinical review involved a routine glaucoma assessment (*i.e.* IOP, fundus biomicroscopy and visual fields at 3 months, 6 months and 1 year).

Nd:YAG Laser Goniopuncture LGP was allowed for eyes not achieving a desirable IOP based on the success criteria below. We use a ocular magnaview contact goniolens (Protech Ophthalmics, Brentwood CA) and neodymium-doped:yttrium-aluminum-garnet (Nd:YAG) laser to puncture Descemet's window creating one to several tiny holes or slits. The energy setting was typically 3-6 mj, 2 to a maximum of 15 shots were used. Care was taken to apply the laser as anterior as possible to minimise the risk of iris prolapse or incarceration. The end point was reached when a hole, fracture, slit, flap or scroll of tissue was formed in the TDW. All antiglaucoma medications were stopped post laser. None of the patients were commenced on steroid/non steroidal drops following LGP.

Success Criteria The measure of success in these eyes was defined as an IOP≤18mmHg with no glaucoma medications at 12 months (complete success), or a total of eyes with an IOP ≤18mmHg without or with 1 permanent glaucoma medication at 12 months (qualified success).

Other parameters analysed included a drop in IOP of 30% or more and no glaucoma medications at 12 months and a total number with a 30% or more drop in IOP without or with 1

permanent glaucoma medication at 12 months. These criteria were additionally evaluated in the context of NPGS followed by LGP.

We have also provided data for the number of eyes achieving success based on a higher cut-off IOP ≤21mmHg to match with previous published studies. All eyes not reaching these targets or those with long term hypotony were deemed failures. Hypotony was defined as an IOP < 5mmHg with a shallow anterior chamber and choroidal detachment. Other failure criterion was a drop in vision to perception of light or worse following surgery.

RESULTS

Data is available for 100 eyes at the 1 year follow up. Two patients died of reasons unrelated to their eye care and have been excluded, 2 patients also did not attend the 12 months visit. Retrospective power calculation for the sample size and effect was (P=0.075). Viscocanalostomy as a sole procedure was performed in 48% (n = 48) of eyes, whilst combined phacoviscocanalostomy in 52% (n = 52). Table 1 demonstrates demographics and characteristics of the cases. Glaucoma type and frequency is provided in Table 2. There was no significant difference between the types of glaucoma and the outcome at month 12, ANOVA (F=1.687, df=2, P = 0. 191). The mean pre-operative listing IOP was 24. 34mmHg (95% CI 23. 60-25. 04), and the mean post operative IOP at 12 months was 14. 8mmHg (95% CI 14. 5-15. 1) (Table 2).

IOP data at 12 months is presented (Table 3, 4). Table 5 shows the IOP outcome for viscocanalostomy/phacoviscocanalostomy. Eyes achieving complete success (for IOP ≤18mmHg) was 76% (n=76), and those with a qualified success (for IOP ≤18mmHg, total without or on 1 permanent glaucoma medication) was 88% (n=88). For Kaplan Meier Survival curves see Figure 1 and 2. Sixty-three percent (n=63) of eyes achieved a 30% reduction in IOP without need for medication and 67% (n=67) without or with 1 permanent glaucoma medication. When patients with normal tension glaucoma (NTG) are excluded these figures were found to be significantly better at 71% (n = 67) without glaucoma medication and 75% (n = 71) total without or with 1 permanent glaucoma medication.

An IOP≤21mmHg without glaucoma medication was achieved in 91% (n=91), whilst total with IOP ≤21mmHg without or with 1 permanent glaucoma medication in 95% (n = 95). Excluding NTG eyes (n = 16), IOP ≤ 21mmHg without permanent glaucoma medication was achieved in 90% (n=79), and total IOP ≤ 21mmHg without or with 1 permanent glaucoma medication in 94% (n=83).

Table 4 shows the IOP characteristics at 12 months for eyes undergoing viscocanalostomy or phacoviscocanalostomy. There was no statistically significant difference in mean IOP reduction between the two groups, t-test for equality of means (0.445, df 102, P=0.657) for IOP at month 12. However the Kaplan-Meier survival analysis (Figure 1) shows phacoviscocanalostomy was superior at lowering the IOP to less

Table 1 Demographics, previous surgery, pre-treatment, pre-follow up

Demographics, previous surgery, glaucoma treatment and follow up	n(%)
M/F	57/47
R/L	47%/53%
Previous surgery	43%
Cataract surgery	38(36%)
Trabeculectomy and MMC	6(6%)
Viscocanalostomy	1(1%)
Glaucoma treatment	
On at least one medication	104(98%)
On more than 3 medications	36(34%)
Mean drops	3
Mean follow up before surgery (mo)	8.7

Table 2 Glaucoma type

Glaucoma type	n	%	Mean listing (mmHg)	Lower 95% CI	Upper
POAG	70	70	14.90	14.11	15.69
NTG	16	16	13.56	12.09	15.03
NAG	7	7	15.43	11.44	19.42
OHT	2	2	16.50	25.60	35.56
ARG	1	1	15.00	-	-
PXF	2	2	11.50	5.15	17.85
NVG	1	1	18.00	-	-
Secondary	1	1	16.00	-	-

POAG: Primary open angle glaucoma; NTG: Normal tension glaucoma; NAG: Narrow angle glaucoma; OHT: Ocular hypertension; ARG: Angle recession glaucoma; PXF: Pseudoexfoliation glaucoma; NVG: Neovascular glaucoma; Secondary: Secondary glaucoma.

Table 3 Level of IOP and drops at various time points

Time	No. of eyes	Min IOP	Max IOP	Mean IOP	st. dv
Listing	104	14	44	24.34	5.5
Day 1	104	0	45	13.21	7.7
Week 1	104	2	42	15.47	7
Month 1	104	8	32	16.32	5
Month 3	104	6	40	14.65	5
Month 6	104	8	36	15.12	4.5
Month 9	104	8	34	15.33	4.5
Month 12	100	8	24	14.73	3
LGP 12 months		16	34	15.78	5

St. dv: Standard deviation.

Table 4 General success criteria at 12mo including LGP group n(%)

Success criteria	12mo
Complete success ≤18mmHg no medication	76 (76)
Qualified success≤18mmHg +/- glaucoma medication	88 (88)
Complete success ≤21mmHg no medication	91 (91)
Qualified success≤21mmHg +/- glaucoma medication	95 (95)
IOP≥30% reduction No medication	63 (63)
IOP≥30% reduction+/- glaucoma medication	67 (67)
For eyes requiring LGP complete success ≤18mmHg	15 (94)
Failure following LGP	1 (6)

Table 5 Viscocanalostomy and Phacoviscocanalostomy IOP

Surgery type	n	Mean IOP	St. dv	St. error of mean
IOP 12mo				
Viscocanalostomy	48	14.96	3.828	0.541
Phacovisco	52	15.67	2.862	0.389
Percentdifference 12mo/listing				
Viscocanalostomy	48	62%	15.96	2.258
Phacovisco	52	64%	17.40	2.341

St. dv: Standard deviation.

Table 6 Pearson correlation: IOP, age, highest IOP, years of Rx and intervention

Parameters	IOP 12mo	*P*	Age	*P*	Highest IOP	*P*	Treatment (a)	*P*	Intervention	*P*
Pearson correlation										
IOP 12mo	1.000	–	−0.095	0.171	0.165	0.049	0.010	0.460	0.281	0.020
Age	−0.095	0.171	1.000	–	−0.167	0.047	0.197	0.024	−0.116	0.124
Highest IOP	0.165	0.049	−0.167	0.047	1.000	–	−0.105	0.148	−0.101	0.156
Treatment (a)	0.010	0.460	0.197	0.024	−0.105	0.148	1.000	–	0.042	0.339
Intervention	0.281	0.020	−0.116	0.124	−0.101	0.156	0.042	0.339	1.000	–

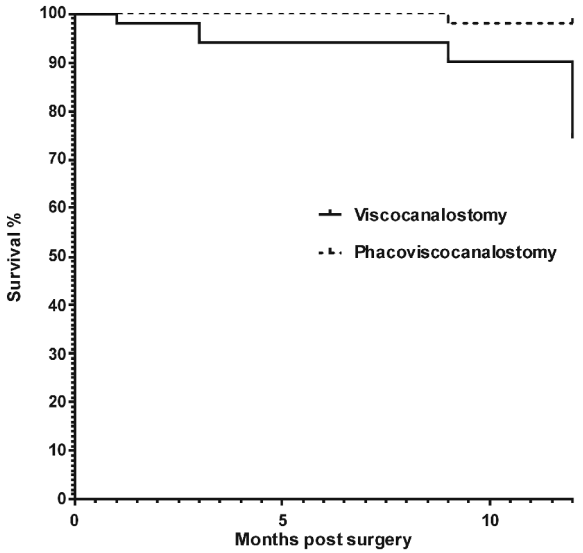

Figure 1 Viscocanalostomy (*n*=48) and phacoviscocanalostomy (*n*=52). Kaplan-Meier survival curves showing maintenance of an IOP≤18mmHg without medication. Log rank test, *P*=0.0005.

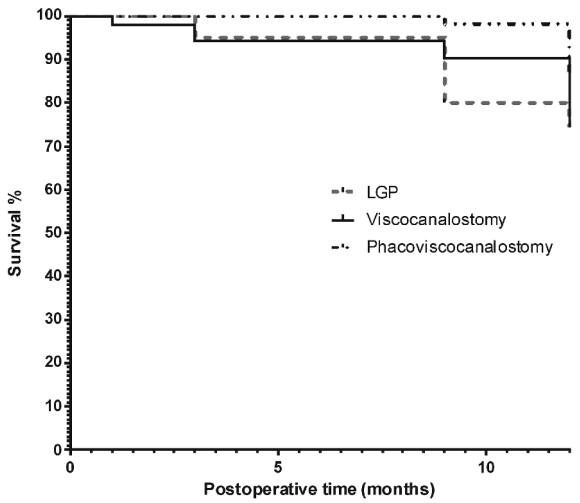

Figure 2 Viscocanalostomy, phacoviscocanalostomy and laser goniopuncture (LGP) (*n*=16) Kaplan-Meier survival curves for IOP≤18mmHg without medication. Logrank test, *P*=0.1825.

than 18mmHg without medication, log rank test $P=0.005$. Figure 2 is survival analysis for all groups including the LGP treated eyes.

Post operatively 15% of patients required some form of temporary medical intervention. Post-op oral Acetozolamide was required in one patient on day one with an IOP of 33mmHg, and 2 patients with IOP 36mmHg at week 1. Sixteen eyes required Nd:Yag laser goniopuncture (LGP) post operatively to further control their IOP at various time points, a majority (40%) of episodes at 6 months post surgery. The pre Nd:Yag laser goniopuncture mean IOP was 26.6mmHg (SD 5.8, 95% *CI* 23.6-29.6), the post laser mean IOP at 3 months was 20mmHg (SD6, 95% *CI* 17-23). There was a 24.8% post procedure reduction in mean IOP ($P=0.0002$). All patients maintained a drop in IOP at least 3 months following laser, longer follow up is not yet available. Only 1 of the LGP eyes required one permanent medication to maintain the IOP, the rest had a successful outcome following LGP and did not require additional treatment. An IOP below 18mmHg without treatment was maintained in 94%. No early or late complications were encountered following LGP, this includes the absence of iris incarceration.

Duration of treatment before surgery, age, IOP, and any intervention was also determined. The mean age was 72 years; mean number of years on treatment was 8.4 years, mean IOP 14.85mmHg. Pearson correlation and significance data is presented in Table 6. These data show very weak correlation between all these factors. The correlation between intervention (Nd: Yag Goniopuncture or oral Acetozolamide) and final IOP at month 12 was low although statistically significant (Pearson correlation 0.281, $P=0.020$).

Complications The commonest intra-operative complication was inadvertent perforation into the anterior chamber in 15% (*n*=15), 3 eyes had excessive subconjunctival bleed on the operating table 3% (*n*=3) requiring and responding to further haemostasis with focal cautery. Early complications were defined as those observed within 2 weeks of surgery. Post-op (day 1 hypotony) was evident in 1 case (1%) case. This patient had an inadvertent perforation into the anterior chamber per-operatively.

Late complications (defined as those observed after 2 weeks) were scarce. One phacoviscocanalostomy eye had developed cystoid macular oedema at the 4 week post operative review which was fully responsive to medical treatment.

DISCUSSION

The Early Manifest Glaucoma trial (EMGT) showed in eyes with newly diagnosed glaucoma, intervention to lower the intraocular pressure is critical to prevent further deterioration[1]. The Advanced Glaucoma Intervention study (AGIS) noted a lower IOP is critical to prevent glaucoma

progression[8]. Historically surgery was delayed when managing open angle glaucoma. Some surgeons still maintain a conservative approach to performing surgery; we feel this is due to the documented complications and demanding post-op management following trabeculectomy, which now includes bleb manipulation and releasing sutures.

It is evident IOP lowering is a critical component in glaucoma management. Population studies consistently show that the incidence, severity and progression of glaucoma consistently correlates with elevated IOP[9,10]. In our group there was a 37% overall reduction compared to the mean listing IOP, 38% reduction in the viscocanalostomy group and 36.8% in the phacoviscocanalostomy group. This is comparable to the results in a study by Wishart in which the mean percentage of IOP reduction was 37% in viscocanalostomy alone and 33% in phacoviscocanalostomy[5].

We observed complete success, judged as eyes achieving an IOP≤18mmHg without treatment in 76% of eyes and the total of those with IOP less than IOP≤18mmHg with or without a permanent glaucoma medication was 88%. A choice of success based on 18mmHg was in line with the AGIS study findings, where patients with IOP consistently below 18mmHg at 100% of visits had close to zero progression in visual field deterioration, whilst those with less than 50% of visits with an IOP less than 18mmHg had worsening of 0.63 units based on a visual field defect score set by the investigators[9]. Later studies take this into account and are using 18mmHg as a target IOP.

In our study for viscocanalostomy and phacoviscocanalostomy the Kaplan Meier survival analysis for an IOP≤18mmHg without glaucoma treatment is in favour of phacoviscocanalostomy, logrank test was significant, $P = 0.0005$. In our study viscocanalostomy or phacoviscocanalostomy was not advised in cases where it is common knowledge they are contraindicated, however phacoviscocanalostomy was used for narrow angle glaucoma (NAG). Phacoemulsification as a sole procedure is accepted as a surgical option for moderate NAG as it deepens the anterior chamber. One patient included in the study with neovascular glaucoma (NVG) and numerous medical co-morbidities had undergone previous pan retinal photocoagulation and had a raised IOP, they opted for viscocanalostomy, as this was less invasive than trabeculectomy or a glaucoma drainage device. In cases of NAG, if PAS was extensive and no seepage was seen through the trabeculo-Descemet window during surgery, the membrane was perforated intentionally and peripheral iridectomy performed.

A meta-analysis of 10 RCT's with 458 eyes evaluating the efficacy and safety profile of viscocanalostomy *vs* trabeculectomy has been carried out[10,11]. The studies used in the analysis varied in follow up from 6 months to 1 year. Findings were that the mean IOP difference between trabeculectomy and viscocanalostomy was 2.25mmHg at 6 months, 3.64 at 12 months and 3.42 at 24 months postoperatively in favour of trabeculectomy. It showed viscocanalostomy had much fewer complications, a relative risk of hypotony, hyphaema, shallow anterior chamber and cataract was lower. The mean post operative antiglaucoma medications were lower in the trabeculectomy group, mean difference of 0.93[11]. Another meta-analysis answered similar questions, the success rate was higher in trabeculectomy 45.6% *vs* viscocanalostomy 30.2% at 2 years and the complications in the viscocanalostomy groups were significantly lower[12].

A different randomised controlled prospective study with 50 eyes and a mean follow up of 20 months similarly found trabeculectomy had a higher success rate for complete success 68% *vs* 34%, and fewer numbers of anti-glaucomatous drops. However qualified success and mean IOP was similar in both groups[13].

Another study that compared viscocanalostomy and trabeculectomy is the randomized control trial by Gilmour and colleagues[14]. The mean follow up in the study was 40 months and involved 50 eyes. Their findings were 79% of patients in each group achieved qualified success (defined as IOP less than 18mmHg with or without glaucoma drops). Rates of complete success were lower with 42% complete success in the trabeculectomy group and 21% in the viscocanalostomy group, no statistically significant difference was reported, chi squared test ($P = 0.194$). The probability of success based on Kaplan-Meier survival curves showed the probability of complete success was higher in the trabeculectomy group and that of qualified success was similar in both groups, again these findings were not statistically significant[14]. Another randomized control trial comparing trabeculectomy and viscocanalostomy showed at 2 year follow-up, IOP of 21mmHg or less and more than 6 mmHg was achieved in 76% in the viscocanalostomy ($n = 19$) group and 80% in the trabeculectomy group ($n = 20$)[14].

In a previous prospective study on viscocanalostomy outcomes, qualified success (IOP less than 21mmHg with or without drops at 60 months) was 90%, complete success rate (IOP less than 21mmHg without medication) was 60% at 40 months[5]. Another prospective study yielded an overall success of 94% at 12 months. The success was complete in 74% at 12 months. There were no serious complications in this study[15]. Analysis of our results based on the 21mmHg cut off was higher at 12 months.

A viscocanalostomy/phacoviscocanalostomy study by Wishart comprising 101 eyes had low rates of complications, 4% had a small hyphaema, 5% small choroidal detachments, 1% iris prolapse through the phacoemulsification incision, and 10% intraoperative microperforations of the trabeculo-descemet's window[5]. Other studies reporting complications include a study using primary viscocanalostomy for juvenile open-angle glaucoma. In this study 16 cases (80%) were considered an

overall success, in 11 cases (55%), success was complete. In two cases (10%) had a microhyphaema which spontaneously reabsorbed. Trabeculo-Descemet-membrane microperforation occurred in two cases (10%). In two other cases (10%), Trabeculo-Descemet-membrane perforation occurred and was accompanied by iris prolapse that required peripheral iridotomy[16].

Other studies looking at the safety of viscocanalostomy or canaloplasty had low rates of complications. In a study involving 30 eyes it was reported there were no serious complications encountered[17]. In a prospective and non-randomized study, Chakib *et al*[18] evaluated the clinical results and complications of 107 eyes which underwent viscocanalostomy. An IOP below 21mmHg with or without treatment was observed in 98% at 13 months and in 80% without need for treatment, 7 cases in this study had ocular hypotony (not defined) lasting more than 1 month[18].

In our study, inadvertent perforation into the anterior chamber through the trabeculo-descemet's complex was the commonest intra-operative complication occurring in 15% of eyes. A single eye developed hypotony on day 1 post operatively following inadvertent perforation into the anterior chamber per-operatively, in this case medical management with Guttae Atropine and a Bandage contact lens were sufficient. An early complication could not be used to predict a future IOP outcome at 12 months, Pearson's coefficient (0.294), $P=0.002$.

In our study LGP was performed in 16% of the patients (16 patients). Goniopuncture was also performed shortly after viscocanalostomy if there was insufficient percolation of aqueous humour at the TDM which may be due to inadequate surgical dissection, iris incarceration or fibrosis. The success rate of LGP was excellent, with an immediate reduction in mean IOP of 24.8% (from 26.6 to 20mmHg) $P=0.0002$. At 12 months an IOP less than 18mmHg without glaucoma treatment was evident in 94% ($n=15$). This reduction has been maintained on all cases at 3 months, however the longer-term outcomes are to be fully explored in the future.

A previous study has also employed Nd: YAG goniopuncture to control raised post operative IOP following viscocanalostomy. In this group the mean pre-op goniopuncture IOP was 20.4mmHg and mean post-op IOP was 12.6mmHg[6]. Another study evaluating success and complications of LGP in 33 eyes showed a success, defined as an intraocular pressure (IOP) below 19mmHg with a 30% decrease to be 75% with medications and 33% without[7]. Vuori demonstrated a 44% reduction in IOP in 31 eyes undergoing LGP at 6 months and 3 eyes (10%) had iris incarceration[19]. Other studies have reported peripheral anterior synechiae in 13.2%, hypotony in 4.0%, late acute IOP rise in 1.7%, delayed bleb leak in one (0.6%) and blebitis in 1% of eyes following LGP.

We encountered no early or late complications following LGP in our study. Gonioscopy was not performed routinely unless there was a raised IOP or any other clinical finding warranting it. We also evaluated whether there was a significant difference between glaucoma types and final outcome, statistical analysis did not indicate this was the case (Table 4). Other authors have also combined viscocanalostomy and phacoemulsification for concomitant cataract[20]. The use of viscocanalostomy or canaloplasty are currently being investigated for delivering glaucoma gene therapy. This is a promising prospect and would suggest an ability to dissect to Schlemm's canal has wider applications in the future[21]. The use of viscocanalostomy has also been extended to various glaucoma types. In one such series viscocanalostomy was used for refractory glaucoma following intravitreal triamcinolone injection[22].

The complications following viscocanalostomy and combined viscocanalostomy with phacoemulsification in our study were low. The low rates of complications are consistent with other published studies evaluating viscocanalostomy or phacoviscocanalostomy. Our data show viscocanalostomy and phacoviscocanalostomy to be highly successful at the 1 year review, we attribute this to meticulous surgical dissection. Phacoviscocanalostomy was superior at lowering the IOP below 18mmHg without a need for further glaucoma treatment. We hope to further evaluate individual pre-operative characteristics and the success, to help advance knowledge on individual glaucoma types and outcomes. We advocate the use of viscocanalostomy in early to advanced glaucoma. We will continue to observe and evaluate these patients for long term outcomes or complications.

LGP is recognised as a complimentary adjunct to NPGS contributing toimproved long term outcomes. However, the creation of an anatomically wide and correct TDW is critical for the success of this procedure. Early intervention is advised as the success rate of the procedure drops if fibrosis of the scleral lake sets in, which may be irreversible. In our experience it is safe, effective and relatively easy to perform. We intend to also evaluate the long term outcomes following the procedure.

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