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RESEARCH ARTICLE

An Alternative Method of Phacoemulsification Surgery in Eyes with Functional Trabeculectomies

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ABSTRACT

Aims: To report success proportions in functional trabeculectomised eyes undergoing phaco-emulsifcation with a novel curvilinear capsulorhexis method.

Methods: An observational series. Seventy two eyes of 72 patients were identified who underwent cataract surgery in eyes with functional prior trabeculectomy surgery using a Leweke cannula (cases). A previously reported group of 53 eyes in 53 patient who had routine cataract surgery (not using this technique) post-trabeculectomy surgery was used to compare outcomes (controls).

Main outcome measure: The primary outcome measure was intraocular pressure (IOP) success (IOP ≤21, ≤18, ≤15 mmHg) at 5 years post cataract surgery. Complete success was no new medication or surgical intervention for IOP and partial success was additional medical therapy required to achieve the IOP target.

Results: At final follow-up, the overall failure proportion of the combined groups for an IOP ≤21mmHg was 20% (24/125) at final review. Thirty percent who were a partial success prior to cataract surgery, failed in both controls and cases at final follow-up. Of those who were a complete success prior to phaco-emulsification; 33% were partial successes and 30% failed in the control group; 50% were partial successes and 10% failed in the case group, at final follow-up.

Logistic regression for an outcome of failure showed the Leweke cannula to be protective OR 0.28 (95% CI 0.09 to 0.85, p=0.03). African/Caribbean ethnicity was a risk factor for failure.

Conclusions: Our results suggest that cataract surgery may affect trabeculectomy outcomes, but not as profoundly as is currently perceived. Using the Leweke technique seems to result in earlier medication recommencement, but a strong reduction in the need for further surgical intervention in fully functional trabeculectomies.

Introduction

Cataract and glaucoma are the two most common causes of preventable blindness in the world.[1] Both are age related and hence often coexist. Treatment of cataract is surgical whereas therapy for glaucoma may be medical, laser or surgical.

The incidence of cataract formation in those with glaucoma ranges from 6 to 23% in untreated glaucoma patients. Medical therapy for glaucoma increases this incidence to 7 to 39% with up to 7 years follow-up. Surgical therapy for glaucoma has an even bigger effect raising the incidence of cataract to 20 to 52% with up to 7 years follow-up by surgical therapy.[2]

Trabeculectomy surgery remains the most commonly considered surgical option to lower the intraocular pressure (IOP).[3,4] As mentioned above, cataract formation following trabeculectomy surgery is common; one-third requiring cataract surgery by 2 years [5,6] and two-thirds by 8 years[2]. A commonly held belief is that cataract surgery is deleterious to trabeculectomy function. The literature reports between 0-39% of trabeculectomies fail within 2 years after cataract surgery.[2,8-24] All of the studies reporting phacoemulsification in eyes with functional trabeculectomies are in essence case-series, a few with comparative groups of different types but all subject to potential selection bias. Some studies have looked at the effect of timing of cataract surgery on the success of prior trabeculectomy surgery. A declining risk has been implicated with longer intervals between the two operations.[8,22,23]

Two reports compare extra-capsular cataract extraction (ECCE) with phacoemulsification.[13,17] Both conclude that ECCE has a much worse effect on trabeculectomy function than phacoemulsification. Chen et al reported iris manipulation and surgery within 6 months of the trabeculectomy as being associated with bleb failure.[8] One report has suggested the use of phacoemulsification to increase IOP in eyes with hypotony post trabeculectomy.[25]

Given the high proportion of trabeculectomy failure following phacoemulsification a hypothesis was made that ophthalmic viscosurgical devices (OVD) used to aid continuous curvilinear capsulorhexis (CCC) during cataract surgery may be forced into the trabeculectomy by the higher pressures during phacoemulsification and subsequently remain entrapped in the trabeculectomy. The retained OVD within the trabeculectomy bleb could lead to temporary impaired flow through the bleb compromising its long-term function.

Based on this hypothesis a novel approach to CCC in eyes with functional trabeculectomy was devised. We report a case series here. In an attempt to provide a comparative group, data already collected from a prior audit was utilised.

Methods

From a surgical log of operations by a single surgeon between 2000 and 2014 all cataract operations undertaken in eyes with functional or partially functional trabeculectomies underwent surgery *without* the use of OVD prior to phacoemulsification, were included. Approval for data access was given by the Clinical Audit Department, Moorfields Research and Development.

A total of 127 consecutive phacoemulsification operations in 112 patients were undertaken with this technique in eyes with prior trabeculectomies. An attempt was made to recall all notes of patients in whom this was undertaken.

Bleb needling and post-operative sub-conjunctival injections of steroid and/or 5-fluorouracil up to 3 months post-operatively were considered part of normal post-operative care. In order to make comparison with prior literature the World Glaucoma Association (WGA) guidelines [26] were followed and results presented using an outcome of IOP ≤21, ≤18, ≤15 mmHg. Complete success was defined by one of the above IOP brackets without the need for topical therapy and qualified success was defined by one of the above IOP brackets with topical therapy. If there had been repeat surgical intervention for lowering intraocular pressure (needling or drainage surgery) this was classified as complete failure.

TECHNIQUE

As a first step a Leweke cannula on balanced salt solution, with bottle height at approximately 80cm, is positioned in the anterior chamber. The routine phacoemulsification entry ports are then made. The Leweke cannula is placed such that the flow is directed to aid the folding of the capsule at the early stages of the CCC. The CCC technique needs modifying. CCC forceps are not practical since the anterior chamber easily collapses. A cystotome through the paracentesis is simplest, being careful to maintain the anterior chamber. Figure 1 illustrates how the Leweke is positioned so the flow 'pushes' the flap in the direction the CCC is taking; clockwise if 'pushing' and anticlockwise if 'pulling'

the flap. At the later stages there is a large capsule flap that is much easier to 'pin down' with the cystotome. Since the capsule is not very tense it is helpful to apply gentle downwards pressure as you guide the CCC round, preventing tear-out. On completion of CCC, hydrodissection and routine phaco-emulsification are undertaken. OVD was used for insertion of the intraocular lens since this procedure is difficult with a Leweke and does not involve a high pressure in the anterior chamber. The rationale is that the high IOP during phaco might drive the OVD into the bleb whilst there is no major rise in IOP during forceps lens introduction as in all cases here. This might not be the case were injection used for intraocular lens introduction.

ANALYSIS

For the purposes of this report, where data existed on both eyes the right eye was used in order to remove within person correlation. For expediency of space the results are shown together with a comparative group (see below). Contingency tables with Chi squared tests were used for categorical comparisons and multivariate logistic regression to investigate interactions between explanatory variables. Survival analysis was used to compare time to partial and complete failure between the two groups.

COMPARATIVE GROUP

We have previously published an audit investigating timing of cataract surgery with trabeculectomy.[24] The data from this study that involved cataract surgery after trabeculectomy were used as a comparative group. In this study the hospital electronic patient record of surgical procedures undertaken at Moorfields Eye Hospital, London, was used. All trabeculectomy operations undertaken between 2000 and 2009 were identified. Full sets of notes were obtained from the hospital medical records library and reviewed as they became available. All that had cataract surgery within 2 years of the trabeculectomy were included. Those with any previous intraocular surgery (e.g. vitreoretinal, glaucoma, cornea, trauma), acute angle closure, juvenile/congenital glaucoma, rubeotic glaucoma and combined phaco-trabeculectomy were excluded. If both eyes of one individual were eligible then the more recent eye was chosen for inclusion. Those eyes that were in the study group were removed meaning all eyes had standard phacoemulsification using OVD for the CCC.

Results

DEMOGRAPHICS

Baseline characteristics

Data was obtained from 78 eyes in 72 people (64% of the total number performed) in the current Leweke audit and 53 eyes in 53 people were included from the previous audit. In order to avoid within person corelation the right eyes of those with data from both eyes were used in the analysis. Table 1 shows the baseline characteristics for the two groups. There were more females in the Leweke audit and the time between trabeculectomy and cataract surgery was considerably different between the two groups due to the selection criteria. Twenty eyes in the Leweke audit (29%) were undertaken within 2 years of trabeculectomy surgery. Almost a quarter (24%) were undertaken 9 or more years following trabeculectomy surgery.

Original trabeculectomy details were available for most (62 in the current Leweke audit and 45 in the prior audit group without Leweke). A higher proportion of the prior audit had mitomycin C augmentation.

	Leweke audit N=72	**Comparative no Leweke group N=53**	**P (t-test for continuous and Chi for categorical)**	
Age (mean (SD))	71.8 (12.6)	73.2 (14.0)	P=0.71	
Gender female (%)	41 (57%)	20 (38%)	P=0.03	
Time between trabeculectomy and cataract (years (SD))	6.6 (7.3)		1.2 (0.5)	P<0.000
Time on steroids post-operatively (weeks (SD)	22 (18)	29 (44)	P=0.89	
Ethnicity				
Caucasian/other	53 (74%)	31 (61%)		
Indian	10 (14%)	9 (18%)		
Afro/Caribbean	9 (13%)	11 (22%)	P=0.29	
Diagnosis				
OAG/NTG	46 (64%)	32 (60%)		
PXF	10 (14%)	6 (11%)		
Other	16 (22%)	15 (28%)	P=0.71	
Original trabeculectomy				
No Cytotoxic	11 (18%)	0 (0%)		

	Leweke audit N=72	Comparative no Leweke group N=53	P (t-test for continuous and Chi for categorical)
5 fluorouracil	21 (34%)	5 (11%)	
Mitomycin C	30 (48%)	40 (89%)	P<0.000
Complete success prior to phaco	62 (86%)	47 (87%)	

Table 1: Baseline characteristics of eyes (one per individual) included in the study. (OAG = open angle glaucoma, NTG = normal tension glaucoma, PXF = pseudo-exfoliative glaucoma)

POST-OPERATIVE COURSE

Cataract surgery was uncomplicated in all but one case, where there was vitreous loss in one of the eyes that did not have Leweke. The trabeculectomy failed at two years in this case. Overall follow-up post cataract surgery was for a mean of 7.1 years (standard deviation (SD) 4.4), that in the comparative group being 11.4 years (SD 3.4).

Table 2 shows the results for complete and partial success at last follow-up. This is divided into those in whom there was partial success prior to the cataract surgery and those with complete success prior to the cataract surgery.

		Prior to phacoemulsification			
		Complete success		Partial success	
		No Leweke	Leweke	No Leweke	Leweke
Final follow-up	Complete success	17 (37%)	25 (40%)	-	-
	Partial success	15 (33%)	31 (50%)	5 (71%)	7 (70%)
	Failure	14 (30%)	6 (10%)	2 (29%)	3 (30%)

Table 2: Results for complete and partial success and failure at final follow-up (using ≤21mmHg criterion), subcategorised by success prior to phacoemulsification.

For those who had partial success prior to cataract surgery the same proportion (30%) went on to fail in each group. For those who had complete success prior to cataract surgery, fewer of those who had the Leweke cannula experienced failure, 10% compared to 30% with OVD (Chi=8.1 p=0.02).

This finding was explored in more detail with logistic regression using just those individuals with complete success prior to cataract surgery (Table 3). It can be seen that ethnicity was a likely risk factor for failure. This was explored with contingency tables and the effect seemed to be largely in the African/Caribbean group. Whilst the proportion failing in the Caucasian and Indian groups were similar (14% and 24%) those failing in the African/Caribbean group was much larger (80%).

The time between trabeculectomy surgery and subsequent cataract surgery has previously been reported as important. Using all data there were 2 who had cataract surgery within 6 months; one of whom was a success, and one was a partial success at final follow-up. Twenty had surgery within one year. Repeating logistic regression comparing failure by this binary risk showed no impact.

Exploration using a multivariate model including the four risk factors of age, gender, ethnicity and Leweke cannula confirmed a tendency for ethnicity to be a risk factor for failure and Leweke cannula use to be strongly protective against failure. One of our theories was that using topical steroids for up to 6 months post-operatively to cover the inflammatory period following cataract surgery[27]may contribute to prevention of failure, this did not prove to be the case.

Variable	Total fail		
	Univariate	Multivarate	P
Age	0.981 (0.949-1.014)	0.975 (0.941-1.011)	0.251 0.171
Gender (male vs female)	1.536 (0.579-4.076)	1.414 (0.474-4.216)	0.389 0.534
Leweke	0.245 (0.086-0.700)	0.278 (0.090-0.849)	0.009 0.025
Ethnicity	1.807 (0.978-3.339)	1.649 (0.862-3.157)	0.059 0.131

Variable	Total fail		
	Univariate	Multivarate	P
Diagnosis	1.159 (0.664-2.022)		0.604
Ocular inflammation	0.981 (0.942-1.021)		0.342
Time on steroids post-operatively (weeks)	1.009 (0.996-1.022)		0.158
Time of phaco after traby (yrs)	0.916 (0.790-1.062)		0.243
Time of phaco after traby 0=within 1 year 1 =after 1 year	0.676 (0.214-2.131)		0.504

Table 3: Crude and adjusted odds ratios for risk factors for failure following cataract surgery in eyes with previous complete success trabeculectomy surgery.

The time to restarting medical therapy (figure 2a) and to further surgical intervention (figure 2b) for pressure control was then investigated. It can be seen that those with Leweke cannula had therapy started earlier than those without this technique. Repeat surgical intervention occurred consistently less often in the Leweke group.

Finally, failure by IOP level according to the various WGA defined cut-offs was plotted for one year, 5 years and final review post cataract surgery. This is shown in figure 3. It can be seen that the trends reported above are evident at all pressure levels.

Discussion

Cataract surgery in relation to trabeculectomy surgery is a contentious issue. Trabeculectomy patients are more likely to develop visually significant cataract compared to those on topical ocular hypotensive therapy alone.[7] A third of patients develop cataract 2 years after trabeculectomy[5,6] and this rises to two-thirds after 8 years.[7] There is a paucity of reports of trabeculectomy survival post cataract surgery with long-term follow-up. The literature reports between 0-39% of trabeculectomies failing within 2 years after cataract surgery.[2,8-24] Interpretation of results within this group is always difficult, as the definitions of success and failure are varied, different patient groups, follow-up periods and differences in surgical technique. The two case-control studies reported in the literature showed differing results; one showing that trabeculectomies were more likely to fail following cataract surgery and the other showing no difference in trabeculectomy function in the group that had cataract surgery compared to the group that did not.[9,12] Our own retrospective cohort study showing no difference in success rates in those that had cataract surgery and those that did not after 5 years follow-up.[28]

Our hypothesis was that the avoidance of OVD during CCC would reduce the likelihood of trabeculectomy failure, as the trabeculectomy function would not be compromised due to retained OVD forced into the filtration bleb at the time of phacoemulsification. Our findings are mixed. It seems eyes that have had this technique restart medical therapy earlier but are less likely to need further surgical intervention to lower IOP. One possibility is fact the Leweke group almost all had surgery by other same surgeon whilst a large range of surgeons undertook the surgery in the non-Leweke group. We cannot comment from our data whether this may have had an effect although we think it less likely. It is possible that individual management strategies may account for this finding. The finding is however consistent. It should be noted that decisions to restart treatment are made by different team members, thus the finding may be real. Although a smaller proportion of those with Leweke had follow-up beyond 7 years (34 without Leweke vs 21 with Leweke), there remain a reasonable number reviewed long-term. This suggests the ongoing success may be real.

We found a steady, ongoing failure in those without a Leweke cannula in contrast to the Singapore 5-FU trial who found that failure rates increased with time, the 8-year failure rate being almost double that of the 3-year failure rate.[7,14] The Leweke group continued to fail over 5-7 years but then plateaued.

Whilst we appreciate the weaknesses of comparing two separate audits this does represent one of the largest case series to date investigating long-term trabeculectomy survival following cataract surgery. The failure proportion of the combined groups was 20% (24/126) at final review (average follow-up 11.4 years for controls and 7.1 years for cases) which is encouraging. In order to investigate prior hypotheses of factors contributing to failure we combined the two groups.

There are two reports in the literature,[11,29] which suggest that higher IOP prior to cataract surgery is associated with trabeculectomy failure; one of them suggesting that an IOP >10mmHg is disadvantageous.[29] We undertook this analysis, at 10 and 15mmHg IOP pre-cataract surgery. Final follow-up results post-cataract surgery show only marginal differences for each group; about 5% more failure in the groups with higher IOP. This was

not significant (p=0.26 for 10mmHg and p=0.28 for 15mmHg).

Two studies suggest that bleb failure increases, the closer cataract surgery is performed to the initial trabeculectomy.[8,22] As shown in the results, we had insufficient numbers to draw any conclusions.

Conclusion

Our results suggest that cataract surgery may affect trabeculectomy outcomes, but not as profoundly as is currently perceived.

Using the Leweke technique seems to result in earlier recommencement of medicines, but a strong reduction in the need for further surgical intervention in fully functional trabeculectomies. Case-selection is important for this technique. The technique is technically more demanding; however if it is important to avoid the need for further drainage surgery then this would be a technique of choice.

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Competing Interests Statement

There are no competing interests for any author.

Author Contributions

IEM: planning the study, data analysis, writing first draft and finalisation of manuscript

RGM: data analysis, writing first draft and finalisation of manuscript

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