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CLINICAL STUDY

Glaucoma surgery: trainee outcomes and implications for future training: southeast Scotland

J Welch, A Vani, P Cackett, J Vallance, C Cobb, H Devlin and R Sanders

Abstract

Aim **Postoperative outcome of trainee glaucoma surgery compared with glaucoma specialist consultant surgery. Survey of Scottish consultant ophthalmologists' views on trainee surgery.**

Method **Retrospective analysis of 128 trainee and 176 consultant trabeculectomies, with minimum postoperative follow-up of 2 years. Prospective postal survey of 80 Scottish consultant ophthalmologists.**

Results **Trainees operated mainly on cases of chronic open angle glaucoma, while consultants operated on significantly more complicated glaucomas ($P = 0.0004$). Trainee cases had more bleb leaks ($P = 0.01$), hypotony ($P = 0.05$), early ($P = 0.01$) and late ($P = 0.03$) return to theatre, and bleb interventions ($P = 0.01$). Trainee mitomycin trabeculectomies were associated with higher rates of return to theatre ($P = 0.002$), and cataract extraction within the first postoperative year ($P = 0.002$). Trainee cases of pseudoexfoliation had more early complications ($P = 0.024$), and trainee cases of low tension required more bleb interventions ($P = 0.05$). There was no significant difference ($P > 0.05$) between average intra-ocular pressure control (IOP) at postoperative visit year 1 between consultant (14.3 mm Hg) and trainee (13.9 mm Hg) cases. More than 50% of the 80 Scottish ophthalmology consultants surveyed, indicated that glaucoma surgery training requirements should be retained.**

Conclusions **Trainee trabeculectomy cases showed significantly higher rates of early complications, return to theatres, and bleb interventions compared with consultant cases. Satisfactory IOP control was achieved in both groups at postoperative year 1. Trainee cases require careful preoperative selection, avoiding complicated glaucomas including pseudoexfoliation and low tension, and those that require mitomycin. The majority of Scottish consultants wish to retain glaucoma surgery within the remit of generic training.**

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Department of Ophthalmology, Queen Margaret Hospital, Dunfermline, Fife, UK

Correspondence: R Sanders, Department of Ophthalmology, Queen Margaret Hospital, Whitefield Road, Dunfermline, Fife, KY12 0SU, UK
Tel: +44 (0)138 362 3623; Fax: +44 (0)138 367 4009.
E-mail: roshini.sanders@nhs.net

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Introduction

There has been a significant change in patterns of glaucoma surgery in Scotland and the United Kingdom over the last decade.[1–3] Lesser glaucoma surgeries are being performed against a background of several new and potent anti-glaucoma medications with greater subspecialisation of the trabeculectomy technique and postoperative intervention.[1–4]

Second to cataract surgery, glaucoma surgery hitherto has fulfilled the important role of a common intra-ocular surgical procedure performed by ophthalmic trainees and is thus, a vital component of their surgical training.[5,6] However, the trabeculectomy procedure has become more specialised with the use of anti-metabolites, adjustable sutures, and postoperative bleb interventions, combined with reduction in numbers performed. In light of these changes we wanted to investigate first the outcomes of trainee glaucoma surgeons compared with consultants and second, the views of Scottish consultants on the need to train juniors to perform glaucoma surgery in the future within the remit of generic ophthalmic training.

In 1996, the Royal College of Ophthalmologists established a committee to examine United Kingdom national experience of trabeculectomy. Trainees carried out approximately 33% of the 1450 trabeculectomies

reported on with similar success rates to fully qualified surgeons. However, the qualified surgeons were a mix of non-glaucoma and glaucoma specialists, as well as non-consultant career grades.[7] We report in detail on outcome of United Kingdom ophthalmic trainee glaucoma surgery compared with glaucoma specialist consultant surgery. The results of this were shared with all Scottish ophthalmology consultants, and our study reports on their responses towards future glaucoma surgery training.

Materials and methods

A retrospective analysis of consecutive trabeculectomies performed (not in combination with cataract surgery) in two centres (Edinburgh and Dunfermline) was carried out. The trabeculectomies were all performed between January 1996 and June 2003 by one of two consultant glaucoma specialists or specialist registrars (SpRs) at higher surgical training level, assisted directly by the same consultant glaucoma specialists. In all trainee cases, the specialist registrar was the principle operator carrying out all of the procedure with oral guidance and, if required, with minor assistance from the consultant.

All trabeculectomies were performed using a fornix-based conjunctival flap, triangular or rectangular scleral flap, punch sclerostomy, peripheral iridectomy, and fixed sutures to the scleral and conjunctival flap. Scleral flap suture tension was adjusted intra-operatively taking into account potency of the fistula to facilitate drainage and maintenance of anterior chamber depth. Intra-operatively (5-FU) was applied at a concentration of 25 mg/ml for 5 min and mitomycin-C (MMC) at a concentration of 0.2 or 0.4 mg/ml for 2 min. With both consultants the indication for use of anti-metabolites was based on risk factors for potential trabeculectomy failure.[8]

All patients had postoperative topical steroids for a minimum of 3 months and medical, slit lamp examination on postoperative days 1, 7, and 14, and months 1, 2, and 3. At these visits Snellen's visual acuity, anterior chamber activity and depth, bleb morphology, fundoscopy, and Goldmann tonometry were recorded for all patients. Hypotony was defined as an intraocular pressure control (IOP) of <7 mm Hg postoperatively excluding the first postoperative day. All bleb interventions and 'return to theatre' cases were dealt with by the two glaucoma consultants or the same specialist registrar who carried out the initial operation with scrubbed supervision by the consultant. Bleb interventions such as needling, and anti-metabolite and autologous blood injections were performed at the slit lamp. More complex procedures such as bleb resuturing required 'return to theatre'. All patients were followed up for a minimum of 2 years or more.

In June 2007, Information and Statistics Division Scotland was approached for information on all glaucoma operations performed in Scotland over the past 15 years (Figure 1). This together with information on the outcome of glaucoma trainee surgery was incorporated into a postal questionnaire (consultant glaucoma questionnaire; see Appendix). The latter also included specific questions on consultant specialist interest and views about higher surgical training in glaucoma. The questionnaire was sent out to all Scottish ophthalmology

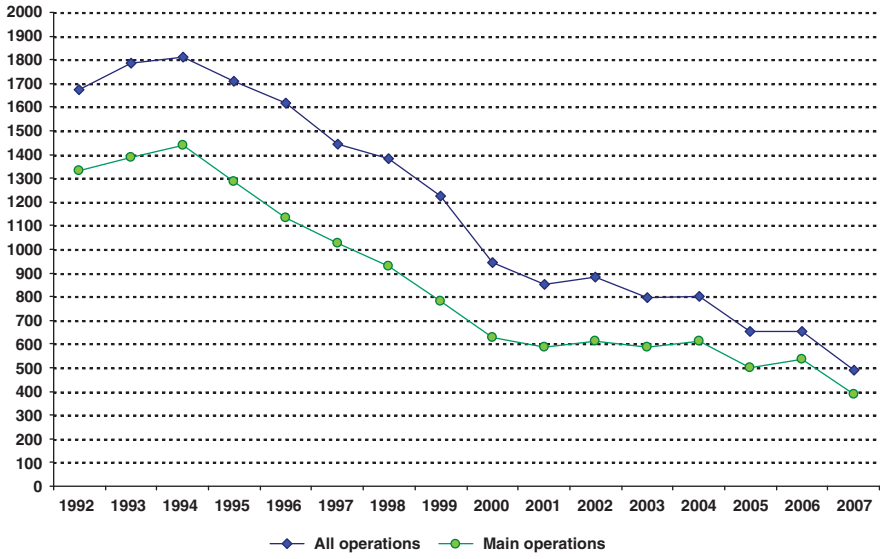

Figure 1 Number of trabeculectomies performed in Scotland between 1992 and 2007.

consultants in October 2007, and results collated in January 2008.

All information was collected on scanning laser forms and manually verified. The information was then transferred to Microsoft Excel for statistical analysis. χ^2 statistical tests were used for categorical variables and a Student's *t*-test or Mann–Whitney *U*-test was used as appropriate for continuous variables. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research.

Results

The case note retrieval rate was 92% (304 of 332), which resulted in 304 trabeculectomies being audited. Of the 28 case notes unretrieved, 10 were destroyed as the patient was deceased and 18 could not be accessed as they were receiving treatment in another hospital or absent from medical records. Of these 304 trabeculectomies, the two glaucoma consultants performed 176 (57.9%) cases, performing 118 and 58 each, and specialist registrars performed 128 (42.1%) cases. The trainees had all completed a minimum of 3 years basic ophthalmology training including ophthalmic surgery (which included mainly cataract, lid and cyst surgery and assisting with ocular motility, and miscellaneous cases) and completed their 6 month block of glaucoma surgery training in years 4–6. There were a total of 24 trainees who performed 2–12 trabeculectomies over 6 months with an average of six trabeculectomies each.

Details of the whole cohort of patients who underwent surgery are shown in Table 1a, together with diagnostic categories, mean values for age, IOP at diagnosis, and IOP at listing. The mean preoperative vision in the consultant group was six out of nine with 118 (67%) patients having vision of six out of nine or better. The mean preoperative vision in the trainee group was also six out of nine with 90 (70%) patients having vision of six out of nine or better. Further analysis of the underlying diagnosis with comparison of consultant and trainee cases is shown in Table 1b. The trainees operated on mainly cases of chronic open angle glaucoma (90, 70.3%) compared with the consultants (88, 50%). Half of the consultant operations (88, 50%) consisted of cases of low tension, pseudoexfoliation, secondary and inflammatory glaucoma, pigment dispersion, and a mixed 'other' group which included acute/chronic angle closure, trauma, and thyroid eye disease. The consultants operated on significantly more cases of complicated glaucoma (88, 50 *vs* 38, 29.7%, $P = 0.0004$). The consultants were also significantly more likely to operate on cases that had undergone previous ocular surgery (47, 26.7 *vs* 26, 20.3%, $P = 0.005$) than trainees. The main previous ocular surgery was cataract extraction (18), trabeculectomy (17) and a miscellaneous group (38).

The numbers of anti-glaucoma medication used before surgery showed no significant difference between

Table 1a Age, presenting and listing IOPs according to diagnostic categories

Diagnosis	*Number of Patients*	*%*	*Mean age (years)*	*95% CI*	*Mean IOP at diagnosis (mmHg)*	*95% CI*	*Mean listing IOP (mmHg)*	*95% CI*
COAG	178	58.6	68.9	67.4–70.4	29.3	28.2–30.4	23.8	22.8–24.7
PXF	21	6.9	71.6	68.2–74.9	34.6	28.3–40.9	26.6	23.6–29.7
Secondary/Inflammation	21	6.9	68.7	67.2–70.2	29.1	28.4–30.2	24.1	23.1–25.1
NTG	23	7.6	72.8	68.9–76.7	20.5	18.3–22.8	18.4	17.2–19.6
Pigment	5	1.6	59.8	44.9–74.7	28.0	15.9–40.1	20.0	17.8–22.2
Others	56	18.4	58.0	53.5–62.5	30.8	27.2–34.4	29.0	26.8–31.3

Abbreviations: CI, confidence interval; IOP, intra-ocular pressure control.

Table 1b Underlying diagnosis in consultant and trainee cases

Diagnosis	*Consultant*	*%*	*95% CI*	*Trainee*	*%*	*95% CI*	P-*value*
COAG	88	50	42.7–57.3	90	70.3	61.9–77.6	<0.01
Second/inflammation	14	8.0	4.7–13.0	7	5.5	2.5–11.1	0.40
PXF	13	7.4	4.3–12.3	8	6.3	3.0–12.0	0.70
NTG	15	8.5	5.1–13.7	8	6.3	3.0–12.0	0.46
Pigment	5	2.8	1.0–6.7	0	0	0.0–3.5	0.06
Others	41	23.3	17.6–30.1	15	11.7	7.1–18.5	0.01
Total	176	100		128	100		

Abbreviation: CI, confidence interval.

consultant and trainee groups, apart from a slightly, significantly more number of patients receiving three medications in the trainee group. The values for these are one medication (17, 9.7 *vs* 10, 7.8%, $P=0.58$), two (69, 39.2 *vs* 40, 31.3%, $P=0.15$), three (60, 34.1 *vs* 60, 46.9%, $P=0.03$) four (23,13.1 *vs* 13, 10.2%, $P=0.44$), and over four (6, 3.4 *vs* 3, 2.3%, $P=0.59$). Over and above this 28 patients in the consultant group and 19 patients in the trainee group also had oral acetozolamide and one patient in the consultant group had only oral acetozolamide. The length of usage of preoperative anti-glaucoma medication was more than 1 year in 143 (81.3%) consultant cases and 115 (89.8%) trainee cases, and this showed a slightly significant difference ($P=0.04$).

The type of glaucoma surgery performed showed no significant difference between consultant and trainee group. Unaugmented trabeculectomy was the main operation performed (85, 48.3 *vs* 72, 56.3%, $P=0.17$) followed by trabeculectomy with 5-FU (56, 31.8 *vs* 35, 27.3%, $P=0.4$), and trabeculectomy with mitomycin (35, 19.9 *vs* 21, 16.4%, $P=0.44$).

There were seven major intra-operative complications. These were two consultant cases, in which one patient suffered massive choroidal haemorrhage and another case, in which lens and vitreous prolapsed into the trabeculectomy ostium, thus requiring lens extraction and vitrectomy. The remaining five were in trainee cases with two cases of significant iris prolapse into the trabeculectomy ostium requiring sector iridectomy, two cases of partial amputation of scleral flap requiring resuturing, and one case of lens capsule perforation during anterior chamber paracentesis requiring cataract extraction.

All early complications (within 1 week of trabeculectomy) of choroidal effusions, shallow anterior chamber, and iridocorneal touch showed no significant differences between the groups (Table 2). Significantly more hyphaemas ($P=0.05$) were noted in the consultant group and significantly more bleb leaks ($P=0.01$) and hypotony ($P=0.05$) in the trainee group.

Early return to theatre (within 1 week of trabeculectomy) was significantly higher ($P=0.01$) in the trainee group (8, 6.3%), compared with the consultant group (2, 1.1%). In the trainee group, six patients required resuture of bleb conjunctiva, one required anterior chamber reformation, and one required anterior chamber washout. In the consultant group, one patient required resuture of bleb conjunctiva and one required anterior chamber washout.

Late return to theatre (beyond 1 week after trabeculectomy) was significantly higher ($P=0.03$) in the trainee group (11, 8.6%) compared with the consultant group (6, 3.4%). In the trainee group, six cases had bleb resuture and five cases had trabeculectomy revision. In the consultant group, two cases had bleb resuture and four cases had trabeculectomy revision.

Table 3 shows the number of postoperative bleb intervention procedures (suturelysis, needling, 5-FU injections, and other interventions such as massage and

Table 2 Early trabeculectomy complications

Complication	*Consultant*	*%*	*95% CI*	*Trainee*	*%*	*95% CI*	P-*value*
Hyphaema	45	25.6	19.7–32.5	21	16.4	10.9–23.9	0.05
Leak	21	11.9	7.9–17.6	29	22.7	16.2–30.7	0.01
Choroidal effusions	17	9.7	6.0–15.0	21	16.4	10.9–23.9	0.08
Hypotony	25	14.2	9.8–20.2	29	22.7	16.2–30.7	0.05
Shallow AC	38	21.6	16.1–28.3	33	25.8	19.0–34.0	0.39
Iridocorneal touch	0	0.0	0.0–2.6	1	0.8	0.0–4.7	0.24
None	85	48.3	41.0–55.6	55	43.0	34.7–51.6	0.36

Abbreviation: CI, confidence interval.

Table 3 Number of postoperative bleb intervention procedures and patient numbers

Interventions	*Consultant*	*%*	*95% CI*	*Trainee*	*%*	*95% CI*	P-*value*
Suturelysis	15	8.5	5.1–13.7	14	10.9	6.5–17.6	0.48
5-FU injection	26	14.8	10.2–20.8	21	16.4	10.9–23.9	0.70
Bleb needling	14	8.0	4.7–13.0	12	9.4	5.3–15.8	0.66
Other	8	4.5	2.2–8.9	17	13.3	8.4–20.3	<0.01
Patients with interventions	40	22.7	17.1–29.5	50	39.1	31.0–47.7	<0.01
Patients without interventions	136	77.3	70.5–82.9	78	60.9	52.3–69.0	<0.01

Abbreviations: CI, confidence interval; 5-FU, 5-fluorouracil.

autologous blood injections) carried out in consultant and trainee cases. The table outlines the absolute number of procedures, with some patients undergoing multiple procedures. There were significantly more bleb interventions ($P<0.01$) in trainee cases (50 patients, 39%) than consultant cases (40 patients, 22.7%). All early and late complications, early and late returns to theatre, and bleb interventions were further analysed for consultant and trainee groups with comparison between unaugmented, 5-FU and MMC trabeculectomies. MMC trabeculectomies performed by trainees showed a significantly higher rate ($P=0.002$) of late return to theatre (4, 19%) compared with unaugmented trabeculectomies (3, 4.2%). Cataract extraction within a year of trabeculectomy was also significantly higher ($P=0.002$) in trainee cases of trabeculectomy with MMC (4, 19%) compared with unaugmented trabeculectomies (1, 1.4%).

All early and late complications, early and late returns to theatre, and bleb interventions were further analysed within glaucoma subgroups. Patients with pseudoexfoliation glaucoma had significantly more ($P=0.024$) early complications (8, 100%) than those with COAG (53, 58.9%) in the trainee group. In addition, patients with low-tension glaucoma (4, 50%) required significantly more ($P=0.05$) bleb interventions than patients with COAG (18, 20%), in the trainee group.

The mean 1 year postoperative vision was six out of nine in the consultant group with 107 (60.8%) patients having vision of six out of nine or better. The mean 1 year postoperative vision was also six out of nine in the trainee group with 78 (60.9%) patients having vision of six out of nine or better. There was no significant difference ($P=0.15$) in visual loss of greater than one line of Snellen's visual acuity 1 year after operation between consultant (23, 13.1%) and trainee (10, 7.8%) cases. There was also no significant difference ($P=0.39$) in rates of cataract surgery within 1 year of trabeculectomy (5, 2.8 % consultant cases *vs* 6, 4.6%, trainee cases) and up to last follow-up (26, 14.8% consultant cases *vs* 19, 14.85% trainee cases $P=0.99$).

Serious late complications consisted of two cases of malignant glaucoma (both within 3 months of trabeculectomy) and two cases of blebitis (both within 18–24 months of trabeculectomy). These cases were evenly split between consultant and trainee. No cases underwent any other incisional intra-ocular surgery other than cataract surgery in the 2 years following trabeculectomy, and there were no complications resulting from this additional surgery. None of the patients required additional trabeculectomy or developed corneal decompensation, cystoid macular oedema or hypotonic maculopathy in the 2 years following trabeculectomy.

Table 4 outlines IOPs documented in consultant and trainee cases 1 year following trabeculectomy and at the most recent postoperative visit (mean 2.74 years after surgery). There was no significant difference between consultant and trainee cases in numbers of patients who achieved an IOP of <21 or 16 mm Hg with and without treatment a year following trabeculectomy. The average IOP at postoperative year 1 was 14.3 mm Hg (range 6–32) for consultants and 13.9 mm Hg (range 6–42) for trainees. The most recent average IOP was 13.8 mm Hg (range 6–26) for consultants and 14.0 mm Hg (range 6–60) for trainees.

IOP was further analysed within the subgroups of glaucoma at every postoperative visit between consultant and trainee cases. The only significant difference was seen at postoperative visit 1 month wherein trainee IOPs were significantly ($P<0.04$) higher in pseudoexfoliation cases (mean 17.0 mm Hg, range 13–26) than consultant IOPs (mean 13.2 mm Hg, range 6–21) and low tension cases wherein trainee cases again showed significantly

Table 4 Intra-ocular pressure control after trabeculectomy

Intraocular pressure (mmHg)	*Consultant*	*%*	*95% CI*	*Trainee*	*%*	*95% CI*	P-*value*
1 year post-op							
IOP <21	163	92.6	87.7–95.7	122	95.3	89.9–98.0	0.34
IOP ≥21	13	7.4	4.3–12.3	6	4.7	2.0–10.1	0.34
IOP <21 with treatment	33	18.8	13.6–25.2	19	14.8	9.6–22.1	0.89
IOP <16	105	59.7	52.3–66.6	86	67.2	58.6–74.7	0.18
IOP <16 with treatment	13	7.4	4.3–12.3	6	4.7	2.0–10.1	0.34
Most recent IOP							
IOP <21	161	91.5	86.3–94.9	125	97.7	93.0–99.5	0.02
IOP ≥21	15	8.5	5.1–13.7	3	2.3	0.5–7.0	0.02
IOP <21 with treatment	35	19.9	14.6–26.4	21	16.4	10.9–23.9	0.44
IOP <16	121	68.8	61.6–75.1	87	68.0	59.4–75.4	0.89
IOP <16 with treatment	16	9.1	5.6–14.3	7	5.5	2.5–11.1	0.24

Abbreviation: IOP, intra-ocular pressure control.

($P<0.008$) higher IOPs (mean 17.0 mm Hg, range 10–26, compared with consultant cases (mean 11.1 mm Hg, range 6–19).

A total of 107 questionnaires were sent to Scottish consultants with 80 received back giving a response rate of 74.8%. In all, 14 (17.5%) consultants had a special interest in glaucoma and 38 (47.5%) currently performed glaucoma procedures. Approximately half (36, 45%) felt trainees should still be required to fulfil 20 glaucoma procedures, as stipulated by the Royal College of Ophthalmology curriculum guidelines before modernising medical careers. In all, 35 consultants (43.8%) felt they should fulfil less and six (7.5%) felt they should complete more glaucoma surgery. The majority (54, 67.5%) felt it was inadequate that trainees should be required to only observe and understand the principles of glaucoma surgery. Only 22 (27.5%) offered trainees access to wet laboratory facilities. The majority (53, 66.3%) felt that glaucoma surgery should be offered to all trainees and not just those that wished to develop a special interest in glaucoma.

Discussion

To our knowledge, this is the largest United Kingdom series looking in detail at the outcome of trainee glaucoma surgery compared with consultant delivered surgery. Our study shows that trainee cases had significantly more early complications and return to theatre compared with consultant cases. The commonest problem was related to conjunctival suturing. This is perhaps not surprising given that typically the trainee's first exposure to intra-ocular suturing techniques is with glaucoma surgery. Two decades ago, extracapsular cataract surgery afforded comprehensive opportunities for intra-ocular suturing and this training opportunity has not been replaced.

Bleb intervention and trabeculectomy revisions were also significantly higher in the trainee group. Henderson *et al*[9] showed a high incidence of post-trabeculectomy bleb leakage (59%), but concluded that this did not have an adverse effect on trabeculectomy outcome. Nevertheless, there is no doubt that meticulous care is required with conjunctival suturing, as well as gauging scleral flap tension to allow drainage of aqueous while maintaining anterior chamber depth and avoiding hypotony. Understandably these surgical techniques can only be developed by experience through exposure to increasing numbers of trabeculectomies. It is established with cataract surgery that complication rates are inversely proportional to numbers performed.[10] Similarly Wu *et al*[11] showed that surgeons who performed ten or more trabeculectomies per annum had less complications than those that performed less.

Trainee cases wherein MMC was used showed a significantly higher rate of return to theatre and cataract surgery in the first year following trabeculectomy. This is perhaps not surprising given that these patients by virtue of requiring MMC would have been the more complicated glaucomas. In addition, MMC is 100 times more potent than 5-FU, causing irreversible fibroblast and vascular endothelium toxicity.[12] Other studies have shown higher rates of early complications in trabeculectomy with anti-metabolites.[13] A national United Kingdom survey of anti-metabolite usage in glaucoma surgery showed that 59% of surgeons did not use MMC at all and 30% used MMC in $<10\%$ of trabeculectomies.[14] Therefore, these more complicated cases requiring MMC should perhaps solely be dealt with by glaucoma consultants.

Trainee cases with pseudoexfoliation showed a significantly higher rate of early complications than those with COAG. It is known that pseudoexfoliation affects all parts of the body including blood vessels, iris, sclera, and conjunctiva.[15] A Scottish study on patients with pseudoexfoliative glaucoma who required trabeculectomy showed a significantly higher incidence of fibrinous reaction in the immediate postoperative phase.[15]

Trainee cases of low-tension glaucoma showed significantly more bleb interventions. Low-tension glaucoma represents a particularly challenging group of patients wherein scleral flap tension is critical to avoid hypotony and yet maintain aqueous flow through the trabeculectomy fistula. These cases would be particularly difficult to assist, with a natural inclination to err on the side of caution and insist on tighter suture tension than if the consultant had been performing the surgery themselves.

Despite all of the above, it is reassuring that IOP control at 1 year following trabeculectomy showed no difference between consultant and trainee cases even when analysed at the lower IOP range of 16 mm Hg or lower. Chan *et al*[16] reported on 50 trabeculectomies performed by supervised residents with rates of complications and overall success similar to that found in the literature. Troutbeck *et al*[17] analysed 95 trabeculectomies and phacotrabeculectomies performed by trainees and found similar rates of complication and IOP control between trainee and consultant. However, the overall percentage of patients achieving an IOP of <16 was low at 30% compared with 68% in our study. In addition, the group was not analysed regarding patient preoperative risk factors and outcome based on the effect of application of anti-metabolites.[17]

In our study, consultants operated on significantly more cases of complicated glaucoma and those who had undergone previous ocular surgery. The only significant

difference in IOP control was found at postoperative visit 1 month in trainee cases of pseudoexfoliation and low-tension glaucoma, in which IOP was significantly higher compared with consultant cases. The possible reasons for this are discussed above. Sung *et al*[18] showed that eyes at low risk for failure had reasonable trabeculectomy success in the hands of non-specialists. Eyes with two or more risk factors, however, were associated with higher postoperative IOPs a year following trabeculectomy.[18]

The limitations of our study are that the patients who had glaucoma surgery were a heterogeneous group with differing glaucoma pathology and previous exposure to ophthalmic surgery, use of anti-glaucoma medication and type of surgery with and without anti-metabolites. Ideally the consultant and trainee groups should have been equally matched for all variables. However, the variables were so numerous that this would have resulted in meaningless analysis of multiple small groups. By 2003, the two glaucoma consultants in this study were performing 25% of all glaucoma surgery in Scotland and therefore, the study cohort represents a reasonable sample of Scottish practise. We therefore, felt that analysing consecutive cases (without exclusions) and careful statistical analysis of every outcome was appropriate. In addition the trainees (although not all identical with regard to previous ophthalmic practice) were all higher surgical trainees in year 4–6 of their training and therefore represented a reasonably homogenous group.

Our postal questionnaire reveals that consultants in Scotland feel that generic training in glaucoma surgery should continue. Although only 14 (17.5%) had a specialist interest in glaucoma, 38 (47.5%) still performed glaucoma surgery. Only 22 (27.9%) consultants worked in departments with access to wet laboratory facilities.

The recently published Royal College of Ophthalmology guidelines on the requirement for glaucoma surgery skills remains vague.[19] There is no clear guidance on the specific numbers required, unlike the American guidelines.[20] This, against a background of declining trabeculectomy numbers and a shortened training period with Modernising Medical Careers, can lead to less access to glaucoma surgery for trainees. It has however been shown that trainees are able to identify their preferred subspeciality interest at an early stage. Perhaps this information should be used to plan individual trainee timetables.[21] Similar to cataract surgery guidelines, there should also perhaps be a mandatory requirement for a microsurgical skills course on suturing techniques and scleral dissection with suitable models for trabeculectomy teaching.[22] This would aid not only glaucoma surgery, but also cases of ocular trauma and other anterior segment surgery thus, giving the trainee invaluable initial experience in a controlled setting. Public information on the Royal College of Ophthalmologists website quotes the average success rate for trabeculectomy at approximately 60%.[23]

In summary, this study concludes that trainee trabeculectomy cases showed a significantly higher rate of early complications, return to theatres, and bleb interventions when compared with consultant cases. However, satisfactory IOP control was achieved in the long term. There should be careful case selection for trainees with avoidance of complicated glaucoma, cases of pseudoexfoliation and low tension, and those that require MMC. Direct intra-operative assistance with meticulous postoperative follow-up and required intervention is recommended for optimum result. There is still a perceived need for generic training in glaucoma surgery and with careful case selection this should still be possible. However, with the changing trend in glaucoma surgery rates and the introduction of MMC, further guidance is required on the exact nature of glaucoma surgery training requirements, with improved arrangements for wet laboratory access to enhance microsurgical skills in suturing and tissue handling for future ophthalmic trainees.

Summary

What was known before

- Gluacoma surgery is becoming increasingly specialised and is performed less frequently than in previous decades. All trainees are required to have performed glaucoma surgery as part of general training.

What this study adds

- A comparison of consultant and trainee surgery outcomes and a survey of consultant opinion on glaucoma surgery during general training.

Conflict of interest

The authors declare no conflict of interest.

References

1 Bateman DN, Clark R, Azuara-Blanco A, Bain M, Forrest J. The impact of new drugs on management of glaucoma in Scotland: observational study. *BMJ* 2001; **323**: 1401–1402.
2 Fraser SG, Wormald RPL. Hospital Episode Statistics and changing trends in glaucoma surgery. *Eye* 2007; **22**: 3–7.
3 Whittaker KW, Gillow JT, Cunliffe IA. Is the role of trabeculectomy in glaucoma management changing? *Eye* 2001; **15**: 449–452.
4 Owen CG, Carey IM, De Wilde S, Whincup PH, Wormald R, Cook DG. The epidemiology of medical treatment for glaucoma and ocular hypertension in the United Kingdom: 1994 to 2003. *Br J Ophthalmol* 2006; **90**: 861–868.

5 Gibson A, Boulton M, Watson M, Fielder A. Surgical training in ophthalmology. *Lancet* 2002; **360**: 1702.
6 Morrell AJ, Searle AE, O'Neil EC. Trabeculectomy as an introduction to intraocular surgery in an ophthalmic training program. *Ophthalmic Surg* 1989; **20**: 557–560.
7 Edmunds B, Bunce CV, Thompson JR, Salmon JF, Wormald RP. Factors associated with success in first-time trabeculectomy for patients at low risk of failure with chronic open-angle glaucoma. *Ophthalmology* 2004; **111**(1): 97–103.
8 O'Bart DPS, Rowlands E, Islam N, Noury AMS. A randomised, prospective study comparing trabeculectomy augmented with antimetabolites with a viscocanalostomy technique for the management of open angle glaucoma uncontrolled by medical therapy. *Br J Ophthalmol* 2002; **86**: 748–754.
9 Henderson HWA, Ezra E, Murdoch IE. Early postoperative trabeculectomy leakage: incidence, time course, severity, and impact on surgical outcome. *Br J Ophthalmol* 2004; **88**: 626–629.
10 Bell CM, Hatch WV, Cernat G, Urbach DR. Surgeon Volumes and selected patient outcomes in cataract surgery. A population—based analysis. *Ophthalmology* 2007; **114**: 405–410.
11 Wu G, Hildreth T, Phelan PS, Fraser SG. The relation of volume and outcome in trabeculectomy. *Eye* 2007; **21**: 921–924.
12 Smith S, D'Amore PA, Dreyer EB. Comparative toxicity of mitomycin C and 5 fluorouracil *in vitro*. *AM J Ophthalmol* 1994; **118**: 332–337.
13 Smith MF, Doyle W, Sherwood MB, Huynh HT. Outcomes followingtrabeculectomy with and without adjunctive antimetabolites at a training institution. *Ann Ophthalmol* 1999; **31**(2): 104–107.
14 Siriwardena D, Edmunds B, Wormald RPL, Khaw PT. National survey of antimetabolite use in glaucoma surgery in the United Kingdom. *Br J Ophthalmol* 2004; **88**: 873–876.
15 Konstas AGP, Jay JL, Marshall GE, Lee WR. Prevalence, diagnostic features and response to trabeculectomy in exfoliation glaucoma. *Ophthalmology* 1993; **100**(5): 619–627.
16 Chan CK, Lee S, Sangani P, Lin L-W, Lin M, Shan C. Primary trabeculectomy surgery performed by residents at a county hospital. *J Glaucoma* 2007; **16**(1): 52–56.
17 Troutbeck R, Lee GA, Sanfilippo P, Fleming B. Trabeculectomy: a training dilemma. *Eye* 2007; **21**(2): 183–186.
18 Sung VCT, Butler TKH, Vernon SA. Non-enhanced trabeculectomy by non-glaucoma specialists: are results related to risk factors for failure? *Eye* 2001; **15**: 45–51.
19 http://curriculum.rcophth.ac.uk/learning-outcomes/surgical_skills/ss5. Learning outcome. Undertake surgical measures to lower intraocular pressure.
20 Golden RP, Krishna R, DeBry PW. Resident glaucoma surgical training in United States residency programs. *J Glaucoma* 2005; **14**(3): 219–223.
21 De Silva DJ, Ramkissoon YD, Fielder AR. Skills acquired during training: a cause for concern. *Br J Ophthalmol* 2007; **91**(9): 1248–1249.
22 Lee GA, Chiang MY-M, Shah P. Pig eye trabeculectomy-a wet-lab teaching model. *Eye* 2006; **20**: 32–37.
23 http://www.rcophth.ac.uk/about/public/glaucoma. Specific questions related to glaucoma.

Appendix

Consultant Glaucoma Questionnaire

Do you have a Special Interest in Glaucoma?
Yes, No

Do you currently perform Glaucoma procedures?
Yes, No

Do you feel that trainees should still be required to fulfil 20 glaucoma procedures during their training?
Yes, No – more, No – less

Do you think that it is adequate that trainees should be required to only observe and understand the principles of glaucoma surgery?
Yes, No

Do trainees at your hospital have access to on-site wet laboratory facilities?
Yes, No, No Trainees

Should glaucoma surgery only be offered to those trainees that wish to develop a special interest in glaucoma?
Yes, No