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CLINICAL STUDY

Intensive cataract training: a novel approach

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Abstract

Purpose **To evaluate the safety of an intensive cataract surgery training programme.**
Methods **An intensive cataract surgery training programme was implemented in August 2010 for year 3 ophthalmology trainees in the East Midlands Deanery North Rotation (United Kingdom). Trainees participated in extra-ocular surgery and 50 h of virtual reality cataract surgery simulator training over a 2-year period. Their third year comprised 6 months of intensive phacoemulsification training in a tertiary centre followed by a 6-month period of consolidation in a district general hospital. The complication rates and case numbers were evaluated after the first 2 years of implementation.**
Results **At 2 years, three trainees had completed a full year of intensive training. In the first 6 months of training, Trainee 1 completed 156 cases, Trainee 2 completed 194 cases, and Trainee 3 completed 151 full cases as primary surgeons with an average rate of posterior capsule rupture (PCR) of 1%. At 12 months, Trainee 1 completed 291, Trainee 2 completed 318, and Trainee 3 completed 294 cases, with an average PCR rate of 0.66%. The trainees required 84 lists on average to complete 150 full cataract procedures.**
Conclusion **The combination of simulation and the new intensive training programme is safer than the traditional programme for cataract surgery training.**
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Keywords: cataract surgery; phacoemulsification; training; teaching; intensive; simulation.

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Introduction

Cataract surgery is one of the most commonly performed surgical procedures worldwide, with over 16 million carried out per year.[1] The phacoemulsification technique of cataract surgery is associated with a significant learning curve. Complication rates are markedly higher for trainee surgeons, but fall with experience.[2] Current standard practice is to withhold information on the grade of the surgeon when consenting patients,[3] even when this is the dominant risk factor for poor outcome. Other risk factors of lesser significance include brunescent or white cataract, phacodonesis, pseudoexfoliation, poor fundal view, and greater patient age.[4]

In the United Kingdom, the Royal College of Ophthalmologists requires that trainees complete 50 phacoemulsification cases over the first 2 years of training, and 350 after 7 years. In the United States, the Accreditation Council for Graduate Medical Education requires trainees to complete 86 cases by the end of 3 years. However, training programmes have more recently been required to focus not only on the number of cases achieved, but also the outcomes achieved. The safety of surgery performed by trainees is also likely to come under greater scrutiny as tools for monitoring complication rates are developed further.[2] To try and meet these challenges a pilot study of an innovative training programme was approved by the Royal College of Ophthalmologists in 2009. This study was designed to examine the effect and practicality of both combining the use of surgical simulation followed by an 'intensive' period of cataract surgical training (ICT) with daily theatre lists. Rather than having trainees undergo 'drip-fed' phacoemulsification training over their first 3 years, they were to participate in cataract training-dedicated daily theatre sessions over 6 months at a tertiary centre in their third year. This was to be followed by a further less intensive 6-month consolidation period in a district general hospital. We also aimed to incorporate techniques identified by educational research as having potential benefits when applied as part of a package of learning.[5,6]

This included 'wet lab' exposure, virtual reality simulation, best practice in case selection, and intra-operative and post-operative learning methods. We report the experience of the first 2 years of this pilot study.

Materials and methods

The training programme began with extra-ocular surgery in specialist training (ST) years 1–2, wet lab experience, and the use of an on-site virtual reality intraocular simulator (EYESI, VRMagic Holding AG, Mannheim, Germany), during allocated study sessions. Trainees completed ~50 h of structured modules on the simulator.

Figure 1 illustrates the design of the programme in ST3. Every 6 months a new trainee would start the intensive portion of the training. The intended number of cases per list and the expected number of cases the trainee would complete per list are shown. The programme design for the first 6 months allowed for 3 weeks of leave, with an expectation that 150 full cases would be achieved in the remaining 21 weeks, with an average of four lists per week. In the second 6-month period at a district general hospital, the trainee would aim to complete a further 100 cases, with an average of two lists per week. The target for the end of ST3 was a minimum of 250 completed cases.

Trainees were to be supervised by a different trainer in each session. A standardised method of cataract surgery was to be taught in order to allow constant repetition by the trainee of a single technique. Lower risk cases were selected initially, whereas towards the end of the first 6 months more complex cases were to be attempted. The surgical steps were learnt in order of difficulty.[7] Each step was to be repeated on subsequent cases until the trainer judged it safe to teach the next. The procedure was to be performed under topical anaesthesia unless the patient had a clear preference or there was an indication for a sub-tenons block. The technique of phacoemulsification taught was to be 'stop-chop' before moving to 'divide and conquer' if desired. The rationale for this was that if the trainee was able to chop and groove they would be well placed to perform both 'phaco-chop' and 'divide and conquer'. All cases were to be videoed, rather like the 'black box' recorder on an aircraft, and all complications reported to and reviewed with the training program director. This allowed a detailed analysis of complications. Regular meetings were held to gauge progress.

Results

Case numbers

The intensive part of the training scheme began in August 2010. To date, three trainees have completed the full ST3 year (Trainee 1, 2, and 3). Trainees had minimal experience in cataract surgery before commencing ICT.

The cumulative number of phacoemulsification procedures completed by the trainees in full with no assistance at the end of each month of the ICT period is shown in Figure 2. All three trainees achieved the target of 150 cases in the first 6 months of the ICT period (156,194, and 151 respectively) and the target of 250 cases by 12 months (291, 318, and 294, respectively).

Complications

The complication of posterior capsule rupture (PCR) and/or vitreous loss at the end of the intensive 6 months was 0.64% (1/156) for Trainee 1, 2.06% (4/194) for Trainee 2, and 0% (0/151) for Trainee 3 giving a

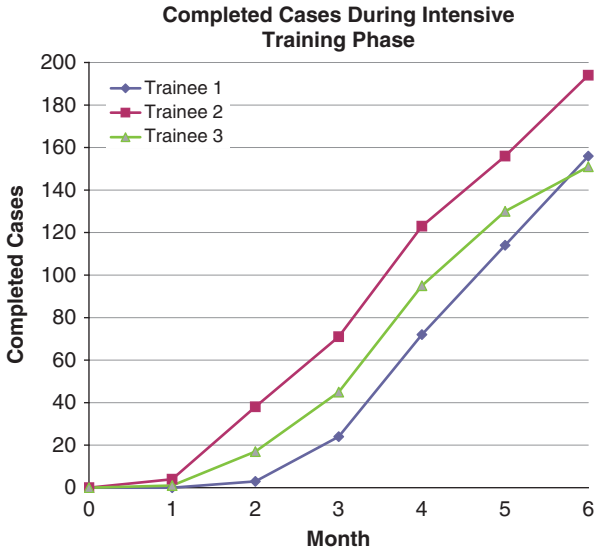

Figure 2 Number of cataract surgery cases completed by each trainee during the intensive phase of the training.

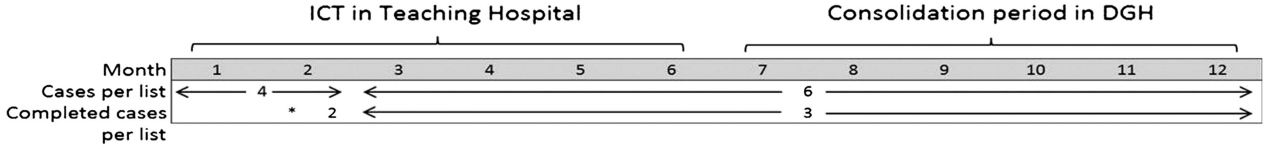

Figure 1 Timeline of ST3 training. *Indicates completion of first full case.

Table 1 Posterior capsule rupture by number of cases completed. Figures from published literature are included for comparison.

	Trainee 1	*Trainee 2*	*Trainee 3*	*Mean*	*Literature*
First 60 cases	0/60 (0%)	2/60 (3.3%)	0/60 (0%)	1.11%	5.49%[13]
First 80 cases	1/80 (1.3%)	3/80 (3.8%)	0/80 (0%)	1.67%	6.3%[12]
First 100 cases	1/100 (1.0%)	3/100 (3.0%)	0/100 (0%)	1.33%	9%[7]
At 6 months	1/156 (0.64%)	4/194 (2.06%)	0/151 (0%)	1%	
At 12 months	1/291 (0.34%)	5/318 (1.57%)	0/294 (0%)	0.66%	

combined rate of 1% at 6 months and 0.66% at 1 year (see Table 1). Trainee 1's PCR was during hydrodissection and resulted in a dropped nucleus. All five (at 12 months) of Trainee 2's PCRs had vitreous loss requiring an anterior vitrectomy, one case as a result of weak zonules. There were no cases of expulsive haemorrhage, retinal detachment, or endophthalmitis during the study period.

The number of theatre sessions required to complete 150 cases was 95, 70, and 87 for Trainee 1, 2, and 3, respectively (mean of 84).

We anonymously surveyed trainers ($n=7$) involved in teaching the intensive trainees. When asked if, on a case-by-case basis, trainees mastered difficult aspects of surgery more rapidly than traditional trainees, 86% either agreed or strongly agreed. If given the choice, 86% of respondents would prefer to teach trainees using the intensive method. All respondents felt that the numbers of cases on each list during the 6-month training period was appropriate.

Discussion

This study has shown that three consecutive trainees undergoing a program of simulator use followed by intensive surgical training had an average complication rate of 0.66% in their first year of performing cataract surgery. A number of authors have published PCR rates for trainees and we found that the PCR rates in this study were considerably lower than these. In a large multi-centre audit, Johnston *et al*[2] found that the overall PCR rate for 79 junior trainees in their first 2–3 years of training was 5.1%, the particular high-risk period is during the first year of cataract training where the PCR rate may be double this.[7]

It is well recognised that a significant learning curve exists for surgeons training to perform cataract surgery. This is the same for experienced surgeons learning the technique for the first time,[8–10] or trainees with no previous experience of intraocular surgery.[2]

PCR with or without vitreous loss is the most common significant intra-operative complication during modern cataract surgery and is widely considered as the benchmark complication to judge surgical quality.[2] PCR, especially with vitreous loss, can be associated with increased morbidity[11] (requiring further surgery or causing reduced final visual outcome) and as such is a measure of high validity for cataract surgeons. Having a junior surgeon operate as the primary surgeon is the single highest risk factor for PCR.[4] Despite this, the experience of the surgeon does not routinely form part of the consent process and thus patients may not be fully aware of what their risk of having a complication actually is.

Randleman *et al*[12] compared the complication rate for the first 80 cataract operations performed by residents to the subsequent complication rate of those residents. The PCR rate was 6.3% during the first 80 cases and reduced to 3.5% ($P=0.2$) afterwards. The vitreous loss rate decreased from 5.1 to 1.9% ($P=0.03$). Our observed PCR rate (all with vitreous loss) was 1.67% in the first 80 cases completed and 0.4% (of 529 cases remaining) after 80 cases had been performed.

Dooley and O'Brien[7] observed 100 consecutive cases performed over an 11-month period by 8 trainees who had already received 9.4 months of surgical training. The PCR rate over this period was 9% (4% with vitreous loss). For the first 100 cases of the trainees in our intensive programme the combined PCR was 1.33% (all with vitreous loss).

The impact of having a structured curriculum involving wet lab and simulator experience has been demonstrated to reduce the PCR rate. Rogers *et al*[13] introduced a structured surgical curriculum (including wet lab and simulator training) and found that the complication rate (PCR or vitreous loss from any other cause) dropped from 7.17 to 3.77% after implementation ($P=0.008$).

Our training programme includes 2 years of extra-ocular surgery with wet lab and simulator experience before commencing intensive cataract training and we were able to achieve an even lower complication rate than Rogers *et al*[13]. Comparison with UK junior surgeons also suggests that web lab and simulator experience may be advantageous in improving safety of surgery. However, it is not possible to ascertain how much the drop in complication rates is attributable to wet lab and simulator experience or to the intensive surgical programme.

A large Swedish study of $\sim$600 000 cataract operations has demonstrated that the PCR rate fell from 2.80% from 2002 to 1.61% in 2009[14] (all levels of surgical experience). It is speculated that much of this improvement has occurred due to improved equipment, techniques and high-volume cataract surgery. The overall PCR or vitreous loss rate in the United Kingdom across all levels of surgical expertise was recently reported as 1.92%.[4]

There is support for high-frequency operating from studies of mortality and morbidity in a range of surgical disciplines. These show a tendency for patients operated on by surgeons who perform a specific procedure more frequently to do better than those patients operated on by

lower volume surgeons.[15–18] Ericsson's work on 'deliberate practice'[19] combines evidence from areas such as music, sport, chess, and medicine to suggest that acquisition and retention of skills is highly dependent on the amount of specific, dedicated practice. Ideally, trainee surgeons should practice specific portions of a case repeatedly to allow them to acquire skills safely.

In the United States, the Accreditation Council for Graduate Medical Education (ACGME) currently requires 86 primary surgeon cases to be completed by the end of residency[12] and residents perform an average of 144 (range 90–211, 10–90th percentile) cases during their training.[20] The ACGME has recently made a commitment to shift from an apprenticeship method of training to a competency-based model whereby emphasis is made on external outcome measures to provide quality and proof of competence in trainees rather than the old model, which focused on number of cases completed as the basis of accreditation.[13]

The provision of training as originally conceived was largely achieved. However, the transition to ICT did have implications for other trainees, in terms of cataracts available to operate on and relative protection from service demands. Although we had planned for trainees to learn phacoemulsification the same way from each trainer, we found that trainers preferred to teach their own technique of cataract surgery. Trainees found it helpful experiencing this variety of methods, for example, 'phaco-chop' versus 'divide and conquer'. The department was committed in the delivery of dedicated cataract training lists for the ST3 trainees undergoing ICT and accepted the financial implications of daily training lists with fewer cases initially.

Cataract surgery remains one of the most challenging procedures to master in ophthalmology training. Surgical outcomes are being subjected to increased scrutiny and this will put increasing emphasis on providing good training without compromising patient safety. Despite the small number of trainees in this pilot, the ICT programme's results have demonstrated that this is achievable.

Contributors

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Summary

What was known before

- Junior surgeons are the dominant risk factor for posterior capsule rupture. Values reported in the literature range from 5 to 9% for the first 60–100 cases.

What this study adds

- This intensive cataract surgery training programme yielded complication rates of ~1% over the first 100 cases. The ability of a carefully designed training programme to dramatically reduce complication rates demonstrates that safety and training need not be mutually exclusive.

Conflict of interest

The authors declare no conflict of interest.

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References

1 RANZCO. [cited 2011, Available from http://www.ranzco.edu/index.php/media-releases/88-the-continuing-evolution-of-modern-cataract-surgery.
2 Johnston RL, Taylor H, Smith R, Sparrow JM. The Cataract National Dataset electronic multi-centre audit of 55,567 operations: variation in posterior capsule rupture rates between surgeons. *Eye* 2010; **24**(5): 888–893.
3 Ross M-A, Avery AJ, Foss AJE. Views of older people on cataract surgery options: an assessment of preferences by conjoint analysis. *Qual Saf Health Care* 2003; **12**(1): 13–17.
4 Narendran N, Jaycock P, Johnston RL, Taylor H, Adams M, Tole DM *et al*. The Cataract National Data set electronic multicentre audit of 55,567 operations: risk stratification for posterior capsule rupture and vitreous loss. *Eye* 2009; **23**(1): 31–37.
5 Henderson BA, Ali R. Teaching and assessing competence in cataract surgery. *Curr Opin Ophthalmol* 2007; **18**(1): 27–31.
6 Lee A. Teaching and assessing surgical competency in ophthalmology. *Ophthalmology* 2006; **113**(12): 2380–2381.

7 Dooley IJ, O'Brien PD. Subjective difficulty of each stage of phacoemulsification cataract surgery performed by basic surgical trainees. *J Cataract Refract Surg* 2006; **32**(4): 604–608.
8 Martin KR, Burton RL. The phacoemulsification learning curve: per-operative complications in the first 3000 cases of an experienced surgeon. *Eye* 2000; **14**(Pt 2): 190–195.
9 Thomas R, Braganza A, Raju R, Lawrence SpitzerKH. Phacoemulsification–a senior surgeon's learning curve. *Ophthalmic Surg* 1994; **25**(8): 504–509.
10 Carricondo PC, Fortes ACFM Mourão, P de C, Hajnal M, Jose NK. Senior resident phacoemulsification learning curve (corrected from cure). *Arq Bras Oftalmol* 2010; **73**(1): 66–69.
11 Ionides A, Minassian D, Tuft S. Visual outcome following posterior capsule rupture during cataract surgery. *Br J Ophthalmol* 2001; **85**(2): 222–224.
12 Randleman JB, Wolfe JD, Woodward M, Lynn MJ, Cherwek DH, Srivastava SK. The resident surgeon phacoemulsification learning curve. *Arch Ophthalmol.* 2007; **125**(9): 1215–1219.
13 Rogers GM, Oetting TA, Lee AG, Grignon C, Greenlee E, Johnson AT *et al.* Impact of a structured surgical curriculum on ophthalmic resident cataract surgery complication rates. *J Cataract Refract Surg* 2009; **35**(11): 1956–1960.
14 Lundström M, Behndig A, Kugelberg M, Montan P, Stenevi U, Thorburn W. Decreasing rate of capsule complications in cataract surgery: eight-year study of incidence, risk factors, and data validity by the Swedish National Cataract Register. *J Cataract Refract Surg* 2011; **37**(10): 1762–1767.
15 McPhee JT, Robinson 3rd, WP, Eslami MH, Arous EJ, Messina LM, Schanzer A. Surgeon case volume, not institution case volume, is the primary determinant of in-hospital mortality after elective open abdominal aortic aneurysm repair. J. Vasc. Surg 2011; **53**(3): 591–599, e2.
16 Begg CB, Riedel ER, Bach PB, Kattan MW, Schrag D, Warren JL *et al.* Variations in morbidity after radical prostatectomy. *N Engl J Med.* 2002; **346**(15): 1138–1144.
17 Schrag D, Panageas KS, Riedel E, Cramer LD, Guillem JG, Bach PB *et al.* Hospital and surgeon procedure volume as predictors of outcome following rectal cancer resection. *Ann Surg* 2002; **236**(5): 583–592.
18 McGrath PD, Wennberg DE, Dickens Jr, JD, Siewers AE, Lucas FL, Malenka DJ *et al.* Relation between operator and hospital volume and outcomes following percutaneous coronary interventions in the era of the coronary stent. *JAMA* 2000; **284**(24): 3139–3144.
19 Ericsson KA. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. *Acad Med* 2004; **79**(10 Suppl): S70–S81.
20 Accreditation Council for Graduate Medical EducationAvailable from: http://www.acgme.org/acWebsite/RRC_240/NAT_REPT_National_Report_Program_Version.pdf.