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Original Article

Long-term outcomes of phacoemulsification cataract surgery performed by trainees and consultants in an Australian cohort

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Abstract

Background: It is unclear whether differences exist in surgical complication rates and long-term visual acuity outcomes between patients whose phacoemulsification cataract surgery was performed by ophthalmological trainees and those performed by consultants.

Design: Prospective clinical cohort study.

Participants: 1851 participants of the Cataract Surgery and Age-related Macular Degeneration study, aged ≥64 years, had cataract surgery performed at Westmead Hospital, Sydney.

Methods: Surgical complication rates and visual acuity at 24-month postoperative visits were compared between patients who were operated on by trainees and those operated on by consultants.

Main Outcome Measures: Surgical outcomes included operative complications recorded in surgical audit forms and 24-month postoperative visual acuity.

Results: Of 1851 patients, 1274 (68.8%) were reviewed 24 months after surgery. Of these, 976 had data on the type of surgeon who performed the operation. After excluding 152 challenging cases and three cases operated on by first-year trainees at the beginning of their training, 821 patients were included in this study, of those, 498 were operated on by trainees and 323 by consultants. Habitual visual acuity ≥6/12 was achieved in 77.3% ($n = 385/498$) and 74.3% ($n = 240/323$), respectively, of the two groups of patients 24 months postoperatively. Of 514 patients who had surgical audit data, the major complication rate was numerically greater, but not significantly different for the 330 trainee-operated (6.1%) patients, compared with the 184 consultant-operated patients (2.7%, $P = 0.091$).

Conclusions: We found relatively comparable complication rates and visual outcomes after 2 years between patients operated on by ophthalmological trainees and those by consultants, in a cataract surgical cohort at Westmead Hospital.

Key words: Australian Prospective Cataract Surgery and Age-related Macular Degeneration study, cataract surgery, visual acuity.

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Introduction

Cataract surgery is the cornerstone of surgical training in ophthalmology. Recent studies indicate that, depending upon their level of training, ophthalmological trainees (also termed 'trainees' or 'registrars') perform 21–39% of cataract surgery in developed countries.[1,2] Early studies reported a higher incidence of intraoperative complications during extracapsular cataract surgery performed by trainees compared with surgery performed by consultants.[3,4] More recently, and with advances in ophthalmological surgical technologies, the complication rates for phacoemulsification (phaco) surgery have diminished, and the visual outcomes of patients specifically operated on by trainees have been shown to have improved. Studies have shown that 77–87% of patients operated on by trainees achieved best-corrected visual acuity (VA) of ≥6/12 12 months postoperatively[5–7] with an incidence of operative complications of 2.6–14.7%.[6–11] There is a correlation between increased training and better supervision, and a lower rate of surgical complications.[9,12]

Although studies have compared the visual outcomes of patients who have had trainees perform phaco surgery at different teaching hospitals,[5,8,13–17] there appear to be no reports that have compared phaco surgical outcomes of patients operated on by ophthalmological trainees and those by ophthalmologist consultants.

The aim of this study was to compare surgical complication rates and VA at 24-month postoperative visits between patients operated on by trainees and those by consultants.

Methods

The Australian Prospective Cataract Surgery and Age-related Macular Degeneration study is a prospective, clinic-based, cohort study of 2027 patients. Details of the study have been described elsewhere.[18] Phaco cataract surgical patients aged ≥64 years were recruited between 2004 and 2007 at Westmead Hospital and at a private ophthalmology clinic in Western Sydney, Australia. Westmead Hospital is a major tertiary hospital that services the Western Sydney region. For this study, we included 1851 out of 1947 patients recruited at Westmead Hospital who had had phaco surgery performed at the time the current data were assembled. To enhance the comparison between the two groups of patients, we excluded challenging cases observed to have pseudoexfoliation, brunescent cataract, corneal pathology (opacity, Fuchs' endothelial dystrophy or guttata), high ametropia (>6 dioptres of myopia or hyperopia), shallow anterior chamber (<2.5 mm), monocular patients, as well as those with a history of ocular trauma, retinal detachment, diabetic macular oedema, uveitis or vitrectomy. These cases were considered difficult cases in previous studies.[2,13,19–23] We also excluded three cases that were operated on by first-year trainees at the beginning of their training.

The study was approved by the University of Sydney and the Sydney West Area Health Service Human Research Ethics Committees and conducted according to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000). Written informed consent was obtained from all participants.

Phaco surgery was performed by any of 20 ophthalmologist consultants, 6 fellows or 45 ophthalmological trainees. Consultants were ophthalmological specialists of the Royal Australian and New Zealand College of Ophthalmologists. Trainees were in their first to fourth year of a 5-year training programme. All trainees performed surgery under the supervision of consultants. The routine practice in our hospital is that the supervising consultant is scrubbed and either standing by or assisting with the operation. Fellows were either senior ophthalmological trainees from overseas or Australian trainees in their final (fifth) year of training who had completed their fellowship examinations. In our study, fellows were combined with consultants as one group to compare with the trainee group.

All patients underwent phaco surgery with capsulorrhexis (mean diameter 5.3 mm), hydrodissection and intraocular lens (IOL) implantation. Of the implanted IOL, 96.5% were within the capsular bag, 3.2% were in the ciliary sulcus and 0.3% were in the anterior chamber. Intraocular lens brands varied: 73.7% was Acrysof SA60AT (Alcon Laboratories, Fort Worth, TX, USA), 13.2% Sensar AR40e (Advanced Medical Optics, Santa Ana, CA, USA), 4.7% MA50BM (Alcon Laboratories), 6.1% Akreos Adapt (Bausch & Lomb, Rochester, NY, USA), 1.7% Akreos Adapt AO (Bausch & Lomb) and 0.6% others.

Operation details, including any intraoperative complication, were extracted during 2010 from surgical audit forms completed by both practitioner groups immediately following surgery. A subset of the sample ($n = 514$, including 184 [35.8%] operated on by consultants and 330 [64.2%] operated on by trainees) had surgical audit data which provided information about surgical complications between the two groups. The audit form asked surgeons to indicate the type of incision made and the occurrence of operative complications from a list, which included capsular tear (either anterior or posterior or both), iris prolapse, wound burn, dropped lens fragment, unplanned vitrectomy, pupil manipulation, capsulorrhexis, excessive eye movement and zonular dialysis. Major operative complications included

posterior capsular tear, wound burn, dislocated lens fragment and unplanned vitrectomy.

Eye examinations were conducted preoperatively, and at one, 12 and 24 months postoperatively. Pinhole VA and VA with habitual correction were measured using a back-illuminated Vectorvision CSV 1000 logMAR chart (Vectorvision Inc, Dayton, OH, USA). Habitual VA was measured without best refractive correction, but wearing current glasses if participants owned a pair that was used regularly. VA was recorded as the number of letters read correctly at 2.44 m (8 ft) and scored as both Snellen and logMAR. If no letters could be read, VA was assessed as counting fingers at 0.61 m (2 ft), hand movements, perception of light or no perception of light. For patients who had already had cataract surgery in their first eye prior to study recruitment, the study eye was the second eye that was operated on following recruitment. Only one eye of each patient was used for the analysis.

Eye examinations have been described previously.[24] Retinal photographic grading provided diagnosis of any retinal conditions that could have contributed to poor vision postoperatively. Glaucoma was self-reported and confirmed by medical records. The International Classification and Grading System for Age-Related Maculopathy and Age-Related Macular Degeneration[25] and the modified Early Treatment Diabetic Retinopathy Study (ETDRS) classification system[26] for diabetic retinopathy were closely followed for the diagnosis of these two conditions.

Demographic data and a medical history were collected preoperatively and verified against patient medical records.

Statistical analysis

SAS (V9.13, SAS Institute, Cary, NC, USA) was used for data analysis. Complication rates, prevalent visual impairment 24 months postoperatively and the mean gains in VA of patients operated on by trainees *versus* consultants were compared using either chi-square statistics (for proportions), student *t*-test (for means of independent groups) and analysis of covariance. The latter was used to make comparisons after adjusting for age and preoperative VA. We also made comparisons of surgical complication rates before and after excluding challenging cases. Adjusted means and 95% confidence intervals are reported.

Results

Of the 1851 patients who had cataract surgery, 577 (31.2%) were initially excluded. Of these, 141 (24.4%) had not yet reached their 24-month assessment, 110 (19.1%) had died, 75 (13.0%) withdrew due to health reasons, 156 (27.0%) declined to continue participation, 60 (10.4%) were no longer contactable and 35 (6.1%) were now living too far away to travel easily. Of the remaining 1274 (68.8%), 976 had data on the type of surgeon who performed their operation.

After excluding 152 challenging cases and three cases operated on by first-year trainees at the beginning of their training, there were 821 (64.4%) with detailed assessment of 24-month postoperative visual outcomes and intraoperative complication rates (Figure 1). There were no significant differences in the preoperative characteristics between patients operated on by the trainee and consultant groups (Table 1).

Only 514 of the 821 patients had complete surgical audit data available to assess operative complication rates. Patients who had audit forms had a slightly higher rate of previous cataract surgery in the fellow eye (24.9% among those with audit data *vs.* 18.5% among those without audit data, $P = 0.036$) and a slightly lower rate of reported glaucoma (7.9% among those with audit data *vs.* 12.5% among those without audit data, $P = 0.035$) (Table 2).

Of 152 patients who were considered challenging cases, 132 had surgical audit forms available to assess intraoperative complications. These 132 patients had a higher rate of iris prolapse (5.3%) than the 514 considered not to be difficult cases preoperatively (1.4%, $P = 0.0055$). The two groups had similar rates of other intraoperative complications.

Of the 514 patients with audit data, 330 (64.2%) were operated on by trainees and 184 (35.8%) were operated on by consultants. A slightly higher proportion of trainees (99.4%) used clear corneal incision than consultants (94.9%) (Table 1). Trainees had eight cases with wound burn, and consultants had none ($P = 0.033$). Of the eight cases with wound burn, seven occurred during surgery by trainees in their first to third years of training and one by a trainee of undetermined stage of training. Trainees had a major intraoperative complication rate of 6.1%, which was numerically greater, but not significantly different from the complication rate for the consultants (2.7%, $P = 0.091$). Trainees in their first 2 years had a similar rate of posterior capsular tear (3.8%) as those in their fourth year (3.9%, $P = 0.98$), compared with the corresponding rate (2.7%) for those operated on by consultants.

At the 24-month postoperative visits, a habitual VA $\geq$6/12 was achieved in 77.3% ($n = 385$) and 74.3% ($n = 240$) of the 821 patients known to be operated on by trainees and consultants, respectively (Table 3). Of 196 participants who did not achieve a habitual VA of 6/12, 20.9% ($n = 41$) had age-related

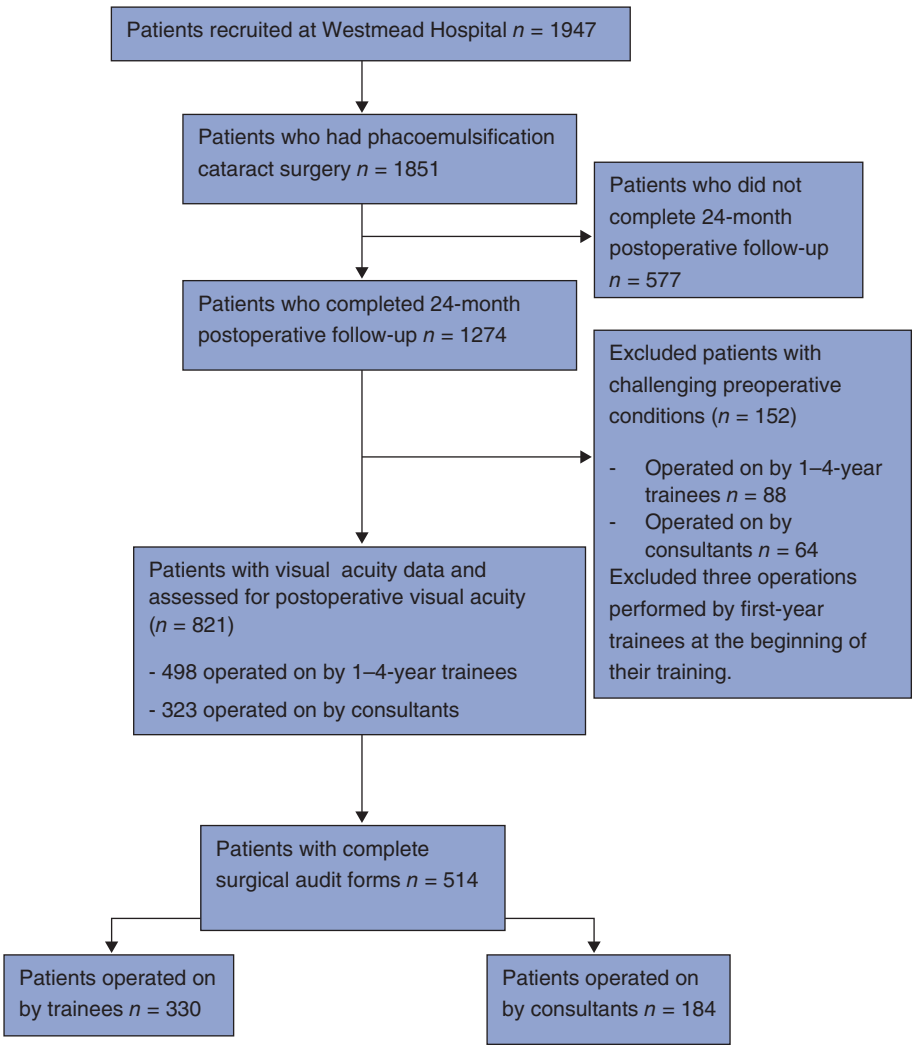

Figure 1. Patient selection for the comparison of surgical outcomes between ophthalmological trainees and consultants in the Cataract Surgery and Age-related Macular Degeneration study. Challenging preoperative conditions included: pseudoexfoliation, brunescent cataracts, corneal pathology, high ametropia (>6 dioptres of myopia or hyperopia), monocular patients, shallow anterior chamber depth (<2.5 mm) or a history of either ocular trauma, retinal detachment, diabetic macular oedema, uveitis or vitrectomy.

macular degeneration, 11.2% ($n = 22$) diabetic retinopathy, 12.7% ($n = 25$) glaucoma and 7.7% ($n = 15$) untreated posterior capsular opacification.

At the 24-month visits, pinhole VA ≥6/12 was achieved in 87.4% ($n = 435$) and 88.2% ($n = 285$) of the two groups of patients, respectively (Table 3). Pinhole VA <6/60 was found in 1.2% ($n = 10$) and 1.6% ($n = 5$) of the 821 patients operated on by trainees and consultants, respectively. Among participants who had wound burns, all but one had habitual VA ≥6/12 by 12 months and maintained a habitual VA of 6/12 at 24 months. Eyes operated on by trainees gained an average 11.8 (95% confidence interval 10.3–13.3) letters, and those operated on by consultants gained 11.8 letters (95% confidence interval 10.0–13.7) 24 months after the surgery ($P = 0.91$, after adjusting for age and preoperative VA).

Of the 821 patients, 16 had cystoid macular oedema (CME) and two had diabetic macular oedema occurring within 6 months and 1 year after cataract surgery, respectively. Of the cystoid macular oedema cases, nine occurred after surgery by trainees and seven after surgery by consultants. Of the cystoid macular oedema cases operated on by consultants, one required further treatment with vitrectomy. There was also a case of laser retinopexy for a retinal tear which occurred within 7 months after cataract surgery performed by a trainee.

Comparisons were also performed without excluding the challenging cases, and the findings were similar. Both consultants ($n = 242$) and trainees ($n = 404$) had similar rates of posterior capsular tear (consultant group 3.7% *vs.* trainee group 3.2%, $P = 0.73$), wound burn (0.4% *vs.* 2.2%, $P = 0.071$), dropped lens fragments (0.8% *vs.* 0.7%, $P = 0.91$) and unplanned vitrectomy (2.1% *vs.* 2.5%, $P = 0.74$) among the 646 cases who had surgical audit data available.

Discussion

In this cataract surgical cohort, we found that patients having phaco surgery performed by trainees

Table 1. Comparison of preoperative characteristics and intraoperative complication rates between patients operated on by trainees and consultants

Characteristic	*N*	Patients operated on by trainees (*N* = 498), *n* (%)	Patients operated on by consultants (*N* = 323), *n* (%)	*P*-value
Preoperative				
Mean age ± SD, years	821	74.2 ± 5.7	74.6 ± 5.8	0.32
Female	821	295 (59.2)	182 (56.4)	0.41
Previous cataract surgery	797	102 (21.0)	77 (24.8)	0.21
Current smoker	812	77 (15.6)	40 (12.6)	0.25
Diabetes mellitus	821	136 (27.3)	81 (25.1)	0.48
Hypertension	820	300 (60.4)	193 (59.8)	0.86
Coronary artery disease†	820	117 (23.5)	69 (21.4)	0.47
Glaucoma	791	41 (8.5)	35 (11.4)	0.17
AMD	739	69 (15.5)	50 (17.1)	0.56
Intraoperative				
Clear corneal incision	491	314 (99.4)	166 (94.9)	0.0012
Complication				
Posterior capsular tear	514	11 (3.3)	5 (2.7)	0.70
Anterior capsular tear	514	16 (4.9)	8 (4.4)	0.80
Iris prolapse/tear	514	6 (1.8)	1 (0.54)	0.23
Wound burn	514	8 (2.4)	0 (0.0)	0.033
Dropped lens fragment	514	2 (0.61)	1 (0.54)	0.93
Vitrectomy	514	7 (2.1)	2 (1.1)	0.39
Pupil manipulation	514	3 (0.91)	2 (1.1)	0.84
Incomplete capsulorrhexis	514	0 (0.0)	1 (0.54)	0.18
Excess movement	514	4 (1.2)	4 (2.2)	0.40
Zonulodialysis	514	3 (0.91)	2 (1.1)	0.84

†Coronary artery disease – history of angina or myocardial infarction. AMD, age-related macular degeneration; SD, standard deviation.

Table 2. Comparison of preoperative characteristics of those patients who had a completed surgical audit forms and those who did not

Characteristic	Patients who had a completed surgical audit form		Patients who did not have a completed surgical audit form		*P*-value
	N	*n* (%)	*N*	*n* (%)	
Preoperative					
Mean age ± SD, years	514	74.4 ± 5.7	307	74.4 ± 5.7	0.88
Female	514	291 (56.6)	307	186 (60.6)	0.26
Previous cataract surgery	499	124 (24.9)	298	55 (18.5)	0.036
Diabetes mellitus	514	132 (25.7)	307	85 (27.7)	0.53
Hypertension	514	306 (59.5)	306	187 (61.1)	0.66
Coronary artery disease†	514	119 (23.2)	306	67 (21.9)	0.68
Glaucoma	494	39 (7.9)	297	37 (12.5)	0.035
AMD	465	71 (15.3)	274	48 (17.5)	0.42

†Coronary artery disease – history of angina or myocardial infarction. AMD, age-related macular degeneration; SD, standard deviation.

were more likely to have wound burns than those having the surgery by consultants, but that this difference was only significant after excluding challenging cases. More importantly, both groups achieved a similar long-term outcome indicated by similar gains in vision. In sensitivity analyses comparing operative complication rates between the two patient groups without excluding challenging cases, all major operative complication rates, including posterior capsular tear, wound burn, dislocated lens fragments and vitrectomy, were not significantly different between the consultant- and trainee-operated groups ($P \geq 0.07$).

Previous studies of senior (third- or fourth-year) ophthalmological trainees have indicated posterior capsular tear rates between 2.6% and 8.8%[10,27–29] and dislocated lens fragments occurring in 0.2% to 1.7% of operated eyes.[6,17,29] The incidence of posterior capsular tear (3.3%) and dislocated lens fragments (0.6%) occurring in the surgical cases performed by trainees in our study is comparable with, but at the lower range of, those reported previously.[10,17,29]

Although this is the only long-term, large-scale prospective study comparing surgical outcomes after phaco surgery performed by either ophthalmological trainees or consultants, our study has several

Table 3. Comparison of 24-month postoperative habitual and pinhole VA of patients operated on by trainees and consultants

	n (%)			*P*-value‡
	Patients operated on by the overall group†, *N* = 821	Patients operated on by trainees, *N* = 498	Patients operated on by consultants, *N* = 323	
Postoperative habitual VA, Snellen scale				
≥6/6	127 (15.5)	82 (16.5)	45 (13.9)	0.33
≥6/12	625 (76.1)	385 (77.3)	240 (74.3)	0.33
<6/12–≥6/60	177 (21.6)	100 (20.1)	77 (23.8)	0.20
<6/60	19 (2.3)	13 (2.6)	6 (1.9)	0.48
Postoperative pinhole VA, Snellen scale				
≥6/6	210 (25.6)	138 (27.7)	72 (22.3)	0.082
≥6/12	720 (87.7)	435 (87.4)	285 (88.2)	0.71
<6/12–≥6/60	86 (10.5)	53 (10.6)	33 (10.2)	0.85
<6/60	15 (1.8)	10 (2.0)	5 (1.6)	0.63

†Includes trainees and consultants. ‡Corresponds to chi-square test for comparison of VA levels between trainees and consultants. VA, visual acuity.

weaknesses. First, only slightly over 500 patients had surgical audit forms completed during the period of data collection, with data available for operative complications. This could have resulted in selection bias if patients with audit data systematically differed from those without audit data. Although patients with audit data had a slightly higher rate of previous cataract surgery in the fellow eye ($P = 0.036$) and a slightly lower rate of reported glaucoma ($P = 0.035$) compared with those with no audit data, the two groups were similar in other preoperative characteristics (Table 2). The audit data, which provided information on operative complications, were completed by surgeons shortly after the operations. Both the audit forms and operation reports were completed by the surgeons at the same time, hence under-reporting of complications in the audit forms is unlikely. Second, patients operated on by the two groups of surgeons are not likely to be exactly comparable between groups, as no randomization procedure was used to allocate a trainee or consultant to each patient, and we did not plan to change clinic practice in this observational study. By excluding both challenging cases and early operations done by first-year trainees, the comparability would have improved, but it would never be as good as in a randomized allocation. Third, given that consultants are more experienced, it is a routine practice that consultants at Westmead Hospital perform cataract surgery on the more complex cases than the trainees, due to the relatively high risk of complications and difficulties of the surgery associated with the condition of these cases. This will lead to less comparability between patients operated on by the two groups of surgeons. Hence, we excluded the challenging cases in primary comparisons of the two patient groups, but this may not completely eliminate this bias. Lastly, subjective refraction was not performed. It should be acknowledged that pinhole VA could underestimate best-corrected VA by up to one line on the logMAR chart.[30]

In summary, this study provides reassuring evidence that intraoperative complication rates and long-term VA levels are relatively comparable between patients who were operated on either by ophthalmological trainees or by ophthalmologist consultants at a large Australian public hospital. The training strategy employed appears to produce excellent surgical outcomes and is likely to account for the high quality of surgical outcomes, as measured by postoperative VA and the relatively low rate of major complications observed.

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