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CLINICAL STUDY

Benchmark standards for refractive outcomes after NHS cataract surgery

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Abstract

Purpose **To establish benchmark standards for refractive outcome after cataract surgery in the National Health Service when implementing the 2004 biometry guidelines of the Royal College of Ophthalmologists and customising *A* constants.**

Methods **Three cycles of prospective data were collected throughout the cataract care pathway on all patients using an electronic medical record system (Medisoft Ophthalmology), between January 2003 and February 2006. The electronic medical record automatically recommends the formula to be used according to the College guidelines and allows *A* constants to be customised separately for either ultrasound or partial coherence interferometry methods of axial length measurement and for different intraocular lens models. Consultants and trainees performed routine phacoemulsification cataract surgery and new intraocular lens models were introduced during the cycles. Uncomplicated cases with'in-the-bag fixation', achieving 6/12 Snellen acuity or better were included. Community ophthalmic opticians performed refraction at 4 weeks.**

Results **The postoperative subjective refraction was within 1 D of the predicted value in 79.7% of the 952 cases in cycle 1, 83.4% of 2406 cases in cycle 2, and 87.0% of 1448 cases in cycle 3.**

Conclusions **On the basis of our data, using College formula, optimising *A* constants and partial coherence interferometry, a benchmark standard of 85% of patients achieving a final spherical equivalent within 1 D of the predicted figure and 55% of patients within 0.5 D should be adopted.**

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Introduction

The percentage of eyes achieving a postoperative spherical equivalent refraction within 0.5 and 1.0 D of the target and the total range of refractive error are the best markers of the quality of a biometry service.[1] The Royal College of Ophthalmologists (RCOphth) 2004 cataract surgery guidelines state that both optical (partial coherence interferometry (PCI)) and acoustic (ultrasound) methods of axial length measurement can be routinely used,[2] although it has been shown that PCI reduces the prediction error of postoperative refractive outcome.[3–5] The RCOphth 2004 guidelines state that each ophthalmology department, if not each surgeon, should personalise the *A* constant on the basis of continuous audit of the comparison of the predicted and actual spherical equivalent of the postoperative subjective refraction.

The RCOphth 2004 guidelines did not set a benchmark standard for the percentage of patients achieving a spherical equivalent within 1 D of the predicted value, although figures between 72 and 97% are quoted.[2,6,7] Setting a benchmark standard would allow all National Health Service (NHS) cataract services to know whether they are achieving a satisfactory standard. It has previously been suggested,[1,8] based upon studies,[3–6] that a benchmark of 85–90% of patient undergoing routine cataract surgery should achieve a final spherical equivalent refraction within 1 D of the predicted value.

This study aims to benchmark refractive outcome in a typical NHS hospital cataract service with the routine use of optical biometry

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whenever possible, different surgeons and customisation of *A* constants through a process of audit.

Materials and methods

Continuous prospective data were collected on all patients undergoing cataract surgery from January 2003 onwards. Three retrospective audit cycles were performed being defined by the introduction of a partial coherence interferometer (PCI Ziess, IOL Master) and by the introduction of two new IOL models. The cycles ran from 1 January 2003 to 31 December 03, 1 January 2004 to 31 October 04, and 18 May 2005 to 9 May 06. Inclusion criteria were uncomplicated phacoemulsification cataract surgery operations with 'in-the-bag' placement of the IOL and a final vision of 6/12 Snellen acuity or better. An electronic medical record system (EMR) (www.medisoft.co.uk) was used to record clinical data throughout the patient care pathway and compulsory data collection included preoperative visual acuity, co-morbidity, biometry details, operating surgeon, their grade, and the model of intraocular lens and its *A* constant, IOL position, operative and postoperative complications. Postoperative refraction was performed by local ophthalmic opticians at approximately 4 weeks, returned by post and entered onto the EMR.

During the first cycle, the IOLMaster had been recently introduced and a single lens, the Rayner Centreflex 570H (570H), was used with the manufacturers' recommended *A* constant. Surgery was performed on a single site. In-house trained nursing staff performed the biometry using either ultrasound (Biovision Axis, Quantel medica Axis-II, Echorule 3M) or PCI (IOLMaster, Zeiss). When axial lengths were measured using acoustic biometry, keratometry readings were obtained using either the Nikon Handheld Keratometer (Nikon, Japan) or the Nidek KM-500 Keratometer (Nidek, Japan) depending on the hospital site of pre-assessment. The Hoffer Q, Holladay or SRK/T formula, or an average of these three formulae was automatically selected using the EMR depending on the axial length in accordance with the RCOphth guidelines on biometry.[2] It was the EMR that was used to select the IOL power.

The second cycle routinely used optical biometry as density of cataract and training of nursing staff allowed. Customisation of the *A* constant for the Rayner Centreflex 570H was performed using retrospective analysis of data and Medisoft Ophthalmology software (Medisoft, Leeds, UK). An optimised *A* constant was determined to ensure that the data were normally distributed around 0 D of deviation. Two operating sites were used (due to the amalgamation of departments) and the AcrySof MA30 IOL (MA30) was introduced for which the manufacturers' recommended *A* constant was used.

The third cycle further customised the *A* constant for the 570H, customised the *A* constant for the MA30 for the first time and introduced the AcrySof SA60 AT IOL (SA60 AT). The *A* constant used for the SA60 AT was taken from the ULIB website[9] based on the experience of other users of the lens and had not been customised for our department specifically.

Analysis of the data aimed to produce percentages of patients who achieved a final spherical equivalent refraction within 1 D of the predicted value, mean absolute errors, standard deviations and 95% confidence intervals.

Results

The total number of operations performed in each cycle along with the number that had complete refractive data returned and those that met the inclusion criteria are shown in Table 1. Customisation of the *A* constant was performed for both ultrasound and PCI biometry for the 570H after the first cycle and for the 570H and the MA30 after the second cycle. Table 2 show the *A* constants used for each cycle. The percentage of patients having PCI for each cycle was 31.4% for cycle 1, 57.4% for cycle 2, and 69.7% for cycle 3.

The overall percentage of patients achieving a spherical equivalent refractive outcome within 1 D of the predicted for all IOL models using either ultrasound or PCI biometry was 79.9% (MAE 0.63, SD 0.75, 95% CI $\pm$ 0.06) for the first cycle, 83.4% (MAE 0.57, SD 0.53, 95% CI $\pm$ 0.02) for the second cycle, and 87.0% (MAE 0.55, SD 0.64, 95% CI $\pm$ 0.05) for the third cycle. The percentage achieving a refractive outcome within 0.5 D was 48.9% for cycle 1, 51.8% for cycle 2, and 60.2% for cycle 3. The breakdown for individual IOL models is given in Table 3 for ultrasound biometry and Table 4 for PCI biometry.

Table 1 The number of cataract operations performed, the number with complete refractive data, and the number meeting the inclusion criteria during each cycle of the audit

	Cycle 1	*Cycle 2*	*Cycle 3*
Total number of operations within the cycle	1769	3575	2592
Number of operations with complete refractive data	974	2527	1792
Number of operations reaching inclusion criteria	952	2406	1448

Table 2 The *A* constants used for the intraocular lens models in each cycle

Intraocular lens model	*A constant used for ultrasound or PCI*					
	Cycle 1		*Cycle 2*		*Cycle 3*	
	Ultrasound	*PCI*	*Ultrasound*	*PCI*	*Ultrasound*	*PCI*
570H	118.0	118.0	118.1[a]	118.6[a]	118.2[a]	118.8[a]
MA30	N/A	N/A	118.4	118.4	118.7[a]	118.8[a]
SA60 AT	N/A	N/A	N/A	N/A	118.4[a]	118.7[a]

[a]Denotes a customised *A* constant.

Table 3 The percentage of patients achieving a final refraction within 1 D of the predicted value for ultrasound biometry for each IOL model used (Rayner 570H, Acrysof MA30, and AcrySof SA60 AT)

Intraocular lens model	*Percentage of patients within 1 D of predicted outcome using ultrasound biometry (no. of patients)*		
	Cycle 1	*Cycle 2*	*Cycle 3*
570H	80.3 (653)	80.5 (501)	81.0 (42)
MA30	N/A	80.3 (535)	83.3 (246)
SA60 AT	N/A	N/A	81.5 (151)
Total	80.3 (653)	80.6 (1036)	82.5 (439)
	(MAE 0.63, SD 0.82, 95% CI±0.06)	(MAE 0.59, SD 0.51, 95% CI±0.03)	(MAE 0.62, SD 0.67, 95% CI±0.06)

Total values for each cycle are also displayed with the mean absolute error (MAE), SD and 95% confidence interval (CI).

Table 4 The percentage of patients achieving a final refraction within 1 D of the predicted value for PCI biometry for each IOL model used (Rayner 570H, Acrysof MA30, and AcrySof SA60 AT)

Intraocular lens model	*Percentage of patients within 1 D of predicted outcome using PCI (no. of patients)*		
	Cycle 1	*Cycle 2*	*Cycle 3*
570H	78.3 (299)	84.8.(634)	91.2 (137)
MA30	N/A	84.0 (746)	88.3 (239)
SA60 AT	N/A	N/A	90.5 (633)
Total	78.3 (299)	84.9 (1380)	89.0 (1009)
	(MAE 0.65, SD 0.60, 95% CI±0.07)	(MAE 0.55, SD 0.55, 95% CI±0.02)	(MAE 0.52, SD 0.62, 95% CI±0.04)

Total values for each cycle are also displayed with the mean absolute error (MAE), SD, and 95% confidence interval (CI).

Figure 1 illustrates the improvement of the percentage of patients reaching a final refractive outcome within 1 D of the predicted value over the three cycles of data collection.

Discussion

We have demonstrated through a process of audit, routine use of optical biometry whenever possible, and continuous customisation of *A* constants that the evolution of a high-quality biometry service is achievable in a NHS hospital setting. This can occur despite normal developments within a cataract service: in this case the introduction of new intraocular lens models, the introduction of new biometry equipment (IOL-Master), and the extension of an EMR to more than one

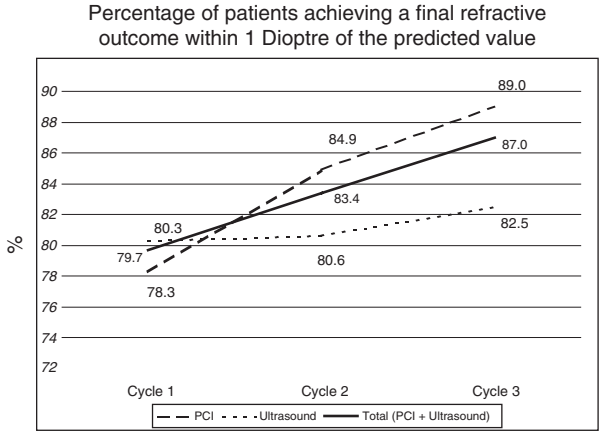

Figure 1 The improvement in percentage achievement of postoperative refraction outcome over the three cycles of audit.

department. At no time was there disruption to the training of junior ophthalmologists. After the third cycle of audit, 87.0% of patients achieved a spherical equivalent refractive outcome within 1 D of the predicted value. We report the largest published dataset so far in the literature with 4806 sets of refractive data analysed.

More than 300 000 cataract operations were performed in the United Kingdom last year. A small increase in the percentage of patients achieving refraction closer to the predicted value could reduce the dependency of many on distance spectacle correction or further intervention to correct iatrogenic anisometropia. Benchmark standards allow ophthalmology departments to judge the quality of their biometry service.

RCOphth guidelines[2] currently suggest that as many as 97% of patients may achieve a refractive outcome within 1 D of the predicted value. This is based upon a study of 500 eyes by Percival, who used ultrasound biometry, similar formula to those recommended, in-house refraction and customised *A* constants for the 570H.[6] Three other studies, using optical biometry without customisation of the *A* constant and much smaller numbers of operations have not been able to achieve such a high percentage: 87% ($n=50$),[3] 87% ($n=111$),[9] and 93% ($n=100$).[5] The figures from these studies, however, are comparable with ours. The RCOphth guidelines also suggest that the figure may be as low as 72% based upon a retrospective series of 1676 phacoemulsification cataract operations using acoustic biometry and not customising *A* constants in a large routine cataract service setting in a post-graduate teaching hospital.[7] With customisation of *A* constants and routine use of PCI, we believe this figure to be too low to be used as a benchmark even in a routine NHS teaching hospital setting.

The use of appropriate biometry formula, PCI whenever possible, and customisation of *A* constants are the most important factors in reducing systematic postoperative refractive errors.[1,8] Customisation of *A* constants for an intraocular lens is important to eliminate systemic errors that may occur due to the differences in the method of axial length measurement or due to sub-optimal manufacturer's *A* constants. For the same intraocular lens (IOL), when using PCI compared with acoustic methods of axial length measurement there can be more than 1 D of difference between customised *A* constants.[10]

We believe, based on the improvement demonstrated with the customisation of the *A* constants for the 570H over the three cycles, our results could be further improved with customisation of the *A* constants for the SA60 AT. The improvement of the performance of the 570H over the three cycles was seen principally with PCI biometry. This is because PCI is an inherently more accurate method of axial length measurement with a higher resolution of 0.012 mm[11] compared to a standard 10-MHz ultrasound transducer of 0.10–0.12 mm[12] and suggest PCI as the first choice over standard ultrasound.

This study calls for a benchmark of 85% of patients undergoing routine NHS cataract surgery to achieve a spherical-equivalent postoperative refraction within 1 D of the predicted value to be established by the RCOphth. This high level of service should be achievable by any cataract service by using the continuous prospective collection of data for audit, the use of PCI whenever possible, and the customisation of *A* constants.

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