National Biometry Audit

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Abstract

Purpose To determine compliance with the Royal College of Ophthalmologists' (RCOphth) biometry guidelines.

Method A structured telephone questionnaire of individuals who perform biometry in all eye departments in the United Kingdom (UK).

Results A biometrist was interviewed in 107 of the UK's 178 eye departments. Nurses alone run the biometry service in 58% of departments, orthoptists alone in 13%, junior doctors alone in 6%, optometrists alone in 3%, and a combination of staff in 20%. Of the staff interviewed, 37% had been on external biometry training courses.

One intraocular lens (IOL) calculation formula was used for all eyes in 61% of departments with 17% using the obsolete SRK II formula, 36% of departments used two or more formulae and only 4% adhered to the RCOphth guidelines to use Hoffer Q in eyes with axial lengths <22.0 mm, an average of all three formulae in eyes between 22.0 and 24.5 mm, Holladay in eyes between 24.6 and 26.0 mm, and SRK/T in eyes >26.0 mm. Audit of refractive results was claimed by 71% of units but in only 17 (16%) did the biometrist know the percentage of eyes with a prediction error ≤1 D.

Conclusion This study demonstrates poor awareness and/or implementation of the RCOphth biometry guidelines and indicates that audits are either not highlighting poor results or are not resulting in a change in practice. The guidelines should be updated to emphasise the importance of customising A constants and to set benchmark standards for prediction error.

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Introduction

Cataract surgery is the most commonly performed operation in the National Health Service with approximately 200 000 being performed each year.[1] Improvements in surgical technique over the last decade, particularly the routine use of phacoemulsification allowing small sutureless incisions and continuous curvilinear capsulorhexis ensuring in-the-bag placement of the intraocular lens (IOL), have improved the predictability of postoperative refraction.[2] The predictability of the refractive outcome also depends on other factors: accurate measurement of the preoperative biometric data (axial length, keratometry, and for some formulae the anterior chamber depth),[3] the accuracy of the intraocular lens formulae, and the accuracy of the IOL manufacturer's quality control and A constants.[4] Preoperative biometry, particularly axial length measurement is the most critical step and is the major cause of prediction errors.[5] Partial coherence laser interferometry axial length measurement is more accurate and reproducible than ultrasound measurement, and has the potential to reduce axial length measurement error.[6] Which IOL calculation formula gives the best results has been hotly debated.[7–10] In the late 1980s and early 1990s, third-generation theoretical formulae which vary the anterior chamber depth value (ACD) based on the patient's axial length and corneal curvature (Holladay,[11] SRK/T,[12] and Hoffer-Q[9]) became almost universally accepted although debate continued regarding which formula was most appropriate for eyes at either end of the axial length spectrum. In 1993 and again in 2000, Hoffer set out to analyse which formula was the most accurate, particularly in long and short eyes.[9,10]

The RCOphth published recommendations regarding all aspects of biometry as part of their cataract surgery guidelines in February 2001. The guidelines include Hoffer's recommendations regarding the most appropriate IOL formula for each axial length interval (Table 1),[1] but do not emphasise the importance of customising A constants despite

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Table 1 Royal College of Ophthalmologists' recommended IOL calculation formulae depending on the axial length of the eye

Axial length (mm)	Formula
< 22.0	Hoffer-Q
22.0–24.5	Average of Hoffer-Q, Holladay, and SRK-T
24.6–26.0	Holladay
>26.0	SRK-T

the results of Hoffer's study that 'strongly support doing so'. The aim of this study was to determine the compliance of UK eye departments with all aspects of the RCOphth biometry guidelines.

Materials and methods

Every ophthalmic department in the United Kingdom was contacted by telephone and a single member of staff who actually performs biometry was invited to participate in a structured questionnaire. The nature and purpose of the study was explained and the person was reassured that the data collected would be anonymous. If they agreed to participate, a short interview was conducted to determine the type of staff performing biometry, what training they had received, what equipment was used, which formulae were applied, and knowledge of audit results. A minimum of seven and a maximum of 12 questions were asked depending on the responses.

Results

All 178 NHS eye departments in the UK were telephoned and in 107 units an individual who performs biometry agreed to be interviewed. In two units biometrists refused to be interviewed, and in 68 units it was not possible to contact a biometrist despite a minimum of two telephone calls.

Personnel

Nurses alone ran the biometry service in 62 departments (58%), orthoptists alone in 14 (13%), and optometrists alone in three (3%). A combination of staff were used in the remaining 22 (20%) units. Junior doctors were routinely performing biometry in 16 units (15%) and were entirely responsible for the service in six departments (6%).

Biometry training

Of the 107 personnel interviewed, 52 (48%) had received only informal 'in house' training from their colleagues, 27

(25%) were taught by the company's representative, and 40 (37%) had been on formal biometry training courses.

A-scan machinery

Contact ultrasound A-scan biometry was exclusively used to measure axial length in 70 departments (65%). Noncontact partial coherence interferometry biometry machines (IOL-Master, Zeiss Humphrey Systems) were used to measure the axial length and keratometry in a proportion of patients in 37 departments (35%).

Intraocular lens calculation formulae

In total, 65 departments (61%) used only one IOL calculation formula regardless of the axial length of the eye, 21 departments (20%) used two formulae, and 20 departments (19%) used three formulae. The obsolete SRK-II formula was regularly used in a total of 18 departments (17%) and was exclusively used in 13 departments (12%). The SRK/T formula was the most commonly used formula and was exclusively used in 49% of departments. No departments reported using the new Holladay 2 formula or the Haigis formula. In departments where more than one formula was used, the axial length of the eye, availability of the A-scan machine, availability of calculation software, or the surgeon's preference determined the choice. In only four (4%) of the departments were IOL calculation formulae used exactly in accordance with the RCOphth guidelines. Of the biometry operators interviewed, 36 (34%) were aware of the RCOphth guidelines.

Audit

Of the biometry operators interviewed 76 (71%) were aware that regular audit of the outcome of cataract surgery was performed in their department; however, in only 17 did the biometrist know the percentage of patients with a prediction error of less than or equal to 1 dioptre (D) (difference between the predicted and achieved spherical equivalent of the postoperative refraction).

Discussion

This study highlights that only 4% of eye departments in the UK have fully implemented the RCOphth February 2001 guidelines on biometry. The guidelines deal with all aspects of biometry including the aims, the care of instruments, biometric data, how readings should be obtained, analysed and interpreted, which formulae should be used, who should perform biometry, how the

process should be audited, and what to do if readings cannot be obtained or if unexpected results occur.

Contact ultrasound biometry is a highly skilled task and is best performed by suitably trained professionals.[1] This study confirms that nurses were the primary staff providing the biometry service in approximately three-quarters of departments and that contrary to the RCOphth guidelines junior doctors were routinely performing biometry in 16% of departments and were the sole provider of the service in 6%. It is of interest that only one-third of staff performing biometry had been on external training courses, although the value of such courses is unproven.

The RCOphth guidelines provide an excellent evidence base that could be applied to alert staff to potential measurement errors. Axial lengths fall within the 21.0–25.5 mm range in 96% of eyes and between 22.5 and 24.5 mm in 60%.[13] K-readings fall within the range 40–48 D in 98% of eyes and between 42 and 45 D in 68%.[13] In the absence of ocular pathology, an interocular difference in axial length of more than 0.3 mm or K readings that vary by more than 1 D should raise suspicion. It is, however, time consuming for staff to manually apply this evidence base to the biometric data at the moment the measurements are performed or for the surgeons to do so immediately before surgery. The solution is to use intraocular lens calculation software that automatically highlights these potential errors and gives immediate feedback to encourage remeasurement or more detailed analysis of the biometry trace. At present such software is not included in any manufacturers' A-scan or keratometry machines, but is available in one ophthalmology electronic patient record system that can be linked directly to A-scan machines.[14]

Which IOL calculation formula is best for eyes in each axial length interval is still the subject of heated debate. The RCOphth guidelines predate the Holladay 2 formula which aimed to provide one formula that was best for all axial lengths, although Hoffer's recent study suggests that his formula is still better than the Holladay 2 formula for short eyes under 22 mm in length.[10] The guidelines do not discuss the merits of the Haigis formula. Several software companies supply programs that allow comparison between different IOL calculation formulae and/or recommendations about which formula to use.[14–17]

The proof of the quality of a biometry service is what percentage of eyes achieves a final postoperative refraction within ±0.5 and ±1.0 D of the predicted value and the total range of prediction error. The RCOphth guidelines emphasise the importance of 'continuously auditing' the difference between the expected and achieved spherical equivalent refraction but fail to set a benchmark standard that should be achieved in an NHS setting. This is vital if departments are to judge the quality of their service. In a recent large UK prospective study of 1817 eyes at Moorfields Eye Hospital, in which the RCOphth IOL formulae guidelines were not followed and A constants were not customised, only 72.3% achieved a final refraction within ±1 D of the predicted value and the range of predictive error for 99% of eyes was +2.92 to −3.98 D.[18] By contrast, when the RCOphth guidelines were almost followed and customised A constants were used, 97% of eyes achieved a final refraction within ±1 D of the predicted value in an NHS setting.[19]

The majority of UK departments (71%) claim to perform regular audit, but in only 17 departments (16%) were the staff performing biometry aware of the percentage of patients achieving a final refraction within ±1 D of the predicted value. As almost no departments routinely use customised A constants and 61% of departments use only one formula regardless of the axial length (with 16% using the obsolete SRK II formula which is known to give poor results[9]), it is certain that poor results in terms of prediction error are the norm nationwide. A review of the literature suggests that if third-generation IOL calculation formulae with customised A constants were routinely used in a similar fashion to the RCOphth guidelines, over 90% of eyes would achieve a final refraction within ±1 D of the expected spherical equivalent.[9,19] As few as 30 operations are required to accurately customise A constants for a particular IOL[9] and the calculation can rapidly be performed using several software programes[14–17] or the IOL Master (Zeiss Humphrey Systems). The RCOphth guidelines make no mention of the importance of customising A constants despite this being 'strongly supported' in Hoffer's paper[9] from which the guidelines were derived.

It is increasingly recognised that manufacturer's A constants may be incorrect even for ultrasound biometry.[4] Since the advent of partial coherence laser interferometry (PCLI) biometry, customisation of A constants has become even more important, since they need to be customised separately for ultrasound and PCLI axial length measurements. Ultrasound A-scan machines calculate the axial length from the time taken for sound to be reflected from the internal limiting membrane of the retina and the assumed speed of sound in the different media of the eye. PCLI measures the actual distance from the anterior surface of the cornea to the retinal pigment epithelium, a distance that is systematically 200 μm longer than that measured indirectly using ultrasound. This systematic difference in axial length measurement may account for a 0.56 D difference in refractive outcome.[5] Using PCLI biometry

and customised A constants, the percentage of eyes achieving a final refraction within $\pm 1\,D$ of the predicted value increases to 87% or better.[20,21] The benefits of customising A constants are easy to apply to NHS departments by routinely performing biometry calculations using appropriate software.

Cataract surgery is one of the most commonly performed operations in the UK, and it is clear from this study that very few eye departments are appropriately auditing their biometry service and acting on the results. The RCOphth guidelines should be updated to recommend customisation of A constants, to establish a benchmark standard for eyes achieving a postoperative refraction within $\pm 1\,D$ of the predicted value, and to define an acceptable range of prediction error. It is perhaps less important to be didactic about which formula/formulae are used to achieve this target.

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