CLINICAL SCIENCE

Does prospective monitoring improve cataract surgery outcomes in Africa?

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Aims: To determine if prospective monitoring influences cataract surgical outcomes in east Africa.
Methods: A prospective observational study of all routine extracapsular cataract extractions with posterior chamber lens implants carried out at Kikuyu Eye Unit, Kenya, between 1 January 1999 and 31 December 1999.
Results: Out of 1845 eligible eyes 1800 were included in the study. Two months' follow up was available in 67.2% of patients. The proportion achieving a good outcome increased steadily from 77.1% in the first quarter to 89.4% in the fourth quarter (χ^2 for trend, p<0.001). There was no change in the incidence of operative complications; however, the proportion of patients achieving a good visual outcome following vitreous loss increased from 47.2% in the first 6 months to 71.0% in the last 6 months (χ^2 p<0.05). Of the eyes with poor outcome (best corrected acuity <6/60 at 2 months) half were due to pre-existing eye diseases. The proportion of patients with known ocular comorbidity decreased from 10.2% in the first quarter to 5.9% in the fourth quarter (χ^2 for trend, p<0.05). Poor outcome was associated with age over 80 years, known diabetes, preoperative bilateral blindness, any ocular comorbidity, and intraoperative vitreous loss.
Conclusions: This study demonstrates improvement in visual outcome results after cataract surgery over a 1 year period. Monitoring of outcomes appears to be associated with a change in surgeons' attitudes, leading to greater emphasis on appropriate case selection, better management of surgical complications, and improved visual outcomes.

Cataract is the world's leading cause of blindness. It is currently estimated that there are over 20 million people blind from cataract in the world. Because of increased longevity, it is projected that, at current rates of surgery, this will increase to 50 million by the year 2020.[1] The vast majority of these cataract blind people live in the poor countries of the developing world, in communities which have limited resources to care for the visually handicapped. In response to this impending crisis, the World Health Organization, together with governments and international non-governmental development organisations, has launched "Vision 2020—the right to sight." This is a global initiative for the elimination of avoidable blindness. The plan calls for the number of cataract operations to be increased from the current level of about 10 million per year to over 30 million per year by 2020. There are already encouraging signs that the quantity of cataract surgery is growing, particularly in India.

However, several community based studies have shown that the visual outcomes of cataract surgery are a cause for concern. In Hyderabad,[2] 21.4% of postoperative eyes had a presenting visual acuity of less than 6/60; in Karnataka[3] 26.4%; and in Shunyi, China,[4] 44.8% of eyes were less than 6/60. In all these surveys, the majority of the patients were aphakic rather than pseudophakic, and uncorrected aphakia was responsible for some of the poor outcomes. The increasingly widespread use of intraocular lenses should lead to improvement in the results of cataract surgery.[5] However, even with best corrected acuity, 16.8% of the eyes in the Hyderabad study still had a vision of less than 6/60.[2] In Mysore,[6] only 12.5% of bad outcomes were thought to be due to refractive error. In industrialised countries, a population based survey of people aged over 40 in Australia showed that 89% of eyes operated for cataract achieved a corrected vision of 6/18 or better,[7] and in the UK National Cataract Survey 87% of operated eyes achieved 6/12 or better at final refraction.[8]

The results of hospital based prospective studies of cataract surgery in developing countries have usually reported good outcomes. In the Madurai intraocular lens study,[9] 1 year after extracapsular cataract extraction and posterior chamber intraocular lens implantation (ECCE and PC-IOL), 0.6% of patients had a best corrected vision of less than 6/60, and 98.1% had a best corrected vision of 6/18 or better. In a study from Kenya, 1.5% of eyes had a visual acuity of less than 6/60 postoperatively, and 94.3% were 6/18 or better after ECCE and PC-IOL.[10] These studies demonstrate that good outcomes can be obtained in the settings of developing countries. This has led to calls for the quality of cataract surgery to receive at least as much attention as the quantity of surgery.[1 11]

There are a number of possible explanations for the better outcomes in prospective hospital studies, compared with long term population based surveys. It may be that only eye clinics or ophthalmologists with good outcomes report such studies; or the results may be biased by the exclusion of cases at high risk of a poor result. There is also the possibility that prospective evaluation of surgical results may by itself lead to an improvement in surgical outcomes.[12] This study was conducted to determine whether monitoring the results of cataract surgery could be used as a method to improve outcomes.

METHODS

A prospective observational study was carried out at Kikuyu Eye Unit for 12 months, from 1 January 1999 to 31 December 1999. Kikuyu Eye Unit is the largest eye clinic in east Africa, performing about 5000 cataract operations per year. Of these, 2500 are carried out in outreach clinics in Somalia, Sudan, and remote parts of Kenya, and are excluded from analysis, as follow up is impossible. There are eight surgeons—four ophthalmologists and four non-physician cataract surgeons. The standard operation for age related cataract is ECCE and PC-IOL.

During the last 6 months of 1998, a database was designed, using Microsoft Access 97, to monitor cataract outcome. A

proforma was developed, with input from all the surgeons and staff involved in the care of cataract patients. Clerical staff were trained in data entry and the use of the database. It was anticipated that clinicians would not have the time to collect additional data, nor to enter data directly into a computer. The proforma was designed to reflect the current practice at Kikuyu so that monitoring of outcomes would not require any additional clinical time. A high priority throughout this process was to ensure that all the surgeons were committed to monitoring outcomes, and had the opportunity to express any reservations they had about prospective evaluation. The database was designed to be accessible, so that any surgeon could call up a report of surgical results at any time. These reports included details of surgery, preoperative and postoperative visual acuities, intraoperative complications, and final refractive error.

Standard practice at Kikuyu Eye Unit is for routine age related cataract surgery to be performed by non-physician cataract surgeons. Patients are only referred to the ophthalmologists if they are less than 50 years old, if it is an only eye, or if the surgery is likely to be complicated in any way. All patients have biometry preoperatively, and are given the IOL most likely to achieve emmetropia. Inclusion criteria were as follows: eyes were included if they had uncomplicated cataract, and the patient was over 20 years old. Eyes were excluded if the cataract was traumatic, or if they had previous surgery and it was known that the eye was unlikely to obtain a vision of 6/60 or better following cataract extraction—for example, previous vitrectomy for long standing retinal detachment, or trabeculectomy for advanced glaucoma. Patients are routinely discharged on the day following surgery. They are seen again at 1 week after surgery, and return for final review and refraction 2 months after surgery.

The routine surgical technique is a limbal section, or modified scleral tunnel, followed by a linear capsulotomy, or a capsulorhexis. The nucleus is hydrodissected, and hydroexpressed. Cortex is removed with a Simcoe cannula, and a single piece PMMA biconvex lens (Aurolab, S3602) is inserted in the capsular bag, under methylcellulose viscoelastic.

Following data collection, the results were analysed on a quarterly basis. An evaluation meeting was held every quarter, at which the results were presented, and all patients with poor outcomes were discussed. All surgeons were present and were able to suggest ways of modifying practice in order to improve outcomes. For example, it was noted that two patients developed corneal oedema following trauma during expression of the lens nucleus. A policy decision was made to use viscoelastic to protect the endothelium if there was any difficulty with nucleus removal. Following this discussion, there were no further episodes of corneal oedema related to expression of the nucleus. All surgeons used the database at other times to check on their results.

During the 12 months of the study, 1845 eyes were eligible for inclusion. Data were missing for 45 eyes, leaving a total of 1800 (97.6%) eyes that were included in the database. One week of follow up was available for 1671 (92.8%), and 2 months of follow up for 1210 (67.2%). Of these, 1200 had an unaided visual acuity recorded and 1172 had a pinhole or best corrected acuity. In accordance with WHO recommendations, good outcome was defined as 6/18 or better, borderline as less than 6/18 to 6/60, and poor outcome as less than 6/60.

Data were analysed by the χ^2 test for trends, and stepwise multiple logistic regression to detect risk factors for poor outcome.

Table 1 Preoperative visual acuity in the operated eye

Vision	No of eyes (%)
6/6–6/18	9 (0.5)
<6/18–6/60	102 (5.7)
<6/60–3/60	135 (7.5)
<3/60–PL	1554 (86.3)
Total	1800

RESULTS

Of the 1800 patients included, 895 (49.7%) were male; the average age was 64 years (SD 13.9, SE 0.32); 197 (10.9%) patients had a history of diabetes; 424 (23.6%) patients were blind (<3/60 in their better eye). Surgery was carried out by a non-physician cataract surgeon in 850 (47.2%) eyes. The remainder were operated by ophthalmologists or by trainees supervised by ophthalmologists. Preoperative vision in the operated eye is shown in Table 1; 147 (8.2%) were known to have other eye disease—these included diabetic retinopathy, open angle glaucoma, uveitis, corneal scar, and trachoma trichiasis. Coexisting eye disease was present in 52/424 (12.3%) blind patients, and 95/1376 (6.9%) patients who were not blind (χ^2 test, p=0.04).

Intraoperative complications are shown in Table 2. The incidence of operative complications did not change during the year. However, only 47.2% of patients who suffered vitreous loss in the first half of the year had a good outcome, compared with 71.0% in the second 6 months (χ^2 test, p<0.05). The number of patients was too small to demonstrate a quarterly trend. There was no significant difference in complication rates between surgeons.

A comparison of patients who did and did not return for follow up at 2 months is shown in Table 3. Known diabetics were more likely to return for 2 month follow up than non-diabetics. Apart from this, there were no significant differences between those patients who returned at 2 months and those who did not. The proportion returning for follow up did not change significantly during the year.

The number of patients with an uncorrected vision of less than 6/60 at 2 months declined throughout the year (Table 4). The number of patients with a good outcome (best corrected vision 6/18 or better) increased during the year (Table 4). A vision of 6/12 or better was achieved by 773 (66.0%) eyes with correction, and by 307 (25.6%) eyes unaided. There were no significant differences in the visual outcomes obtained by different surgeons; neither were there any significant differences

Table 2 Intraoperative complications in 1800 cataract operations at Kikuyu Hospital, Kenya, 1999

	Jan–March	April–June	July–Sept	Oct–Dec	Total
Complication	No (%)	No (%)	No (%)	No (%)	No (%)
Post capsule rupture	29 (7.6)	27 (5.6)	31 (5.7)	27 (7.0)	114 (6.3)
Zonular dehiscence	3 (0.8)	6 (1.2)	6 (1.1)	2 (0.5)	17 (0.9)
Vitreous loss	22 (5.7)	28 (5.8)	31 (5.7)	16 (4.1)	97 (5.1)
Total operations	384	484	544	388	1800

Table 3 Comparison of 1210 eyes with and 590 eyes without 2 months of follow up

	Follow up (n=1210) No (%)	No follow up (n=590) No (%)	Odds ratio	
			OR	95% CI
Age (mean)	64.1 (SD 13.2)	64.3 (SD 15.0)		
Sex (male)	591 (48.8)	280 (47.5)	0.95	0.78 to 1.2
Preoperative blind	273 (22.6)	151 (25.6)	1.2	0.94 to 1.5
Comorbidity	95 (7.9)	52 (8.8)	1.1	0.80 to 1.6
Diabetes	146 (12.1)	51 (8.6)	0.70	0.49 to 0.96
Operative complications	97 (8.0)	44 (7.5)	0.93	0.64 to 1.3

Table 4 Visual acuity at 2 months of follow up, by quarter

	Jan–March No (%)	April–June No (%)	July–Sept No (%)	Oct–Dec No (%)	Total No (%)
Unaided acuity*					
Good	116 (43.6)	135 (41.4)	158 (45.8)	119 (45.2)	528 (44.0)
Borderline	115 (43.2)	162 (49.7)	157 (45.5)	134 (51.0)	568 (47.3)
Poor	35 (13.2)	29 (8.9)	30 (8.7)	10 (3.8)	104 (8.7)
Total	266	326	345	263	1200
Corrected acuity†					
Good	195 (77.1)	266 (82.4)	283 (83.0)	228 (89.4)	972 (82.9)
Borderline	43 (17.0)	52 (16.1)	49 (14.4)	25 (9.8)	169 (14.4)
Bad	15 (5.9)	5 (1.5)	9 (2.6)	2 (0.8)	31 (2.7)
Total	253	323	341	255	1172

*χ^2 test for trend = 13.04, p<0.001; †χ^2 test for trend = 13.0, p<0.001.
Good = 6/18 or better; borderline = <6/18–6/60; poor = <6/60.

Table 5 Mean refractive error at 2 months of follow up, by quarter

	Jan–March Mean (SD)	April–June Mean (SD)	July–Sept Mean (SD)	Oct–Dec Mean (SD)	1999 Mean (SD)
Spherical equivalent	−1.38 (1.44)	−1.62 (1.29)	−1.42 (1.48)	−1.58 (1.28)	−1.50 (1.38)
Absolute sphere	1.59 (1.21)	1.71 (1.18)	1.59 (1.30)	1.67 (1.16)	1.64 (1.22)
Cylinder	2.43 (1.33)	2.39 (1.62)	2.60 (1.83)	2.42 (1.52)	2.47 (1.61)

Table 6 Ocular comorbidity in 1800 eyes undergoing cataract surgery, by quarter

	Jan–March No (%)	April–June No (%)	July–Sept No (%)	Oct–Dec No (%)	Total No (%)
No comorbidity	345 (89.8)	443 (91.5)	500 (91.9)	365 (94.1)	1653 (91.8)
Comorbidity	39 (10.2)	41 (8.5)	44 (8.1)	23 (5.9)	147 (8.2)
Total	384	484	544	388	1800

χ^2 test for trend = 5.5, p<0.05.

in the outcomes obtained by non-physician cataract surgeons and ophthalmologists.

The mean power of PC-IOL inserted was 21.9 dioptres (SD 2.1). Thirteen eyes had an AC-IOL, and four had no IOL.

The postoperative refractions are shown in Table 5. There is no change in the average refractive error during the year. The average spherical equivalent was about –1.5D throughout the year. The mean postoperative cylinder in eyes operated by ophthalmologists was 2.16 dioptres, and in eyes operated by non-physician cataract surgeons, 2.64 dioptres (difference between means = 0.48 dioptres, SE_{diff} = 0.108, 95% CI = 0.27 to 0.69). There was no significant difference in absolute sphere or mean spherical equivalent.

The proportion of patients with known pre-existing eye problems decreased during the year (Table 6).

Of the 31 eyes with a best corrected vision of less than 6/60, the poor outcome was due to preoperative factors in 16 (51.6%), intraoperative complications in 11 (35.5%), and to a postoperative complication in one (3.2%). In four eyes (9.7%), the cause of the poor outcome was not known. The causes of poor outcome are given in Table 7. There were no cases of endophthalmitis.

Risk factors for poor outcome were identified, and the odds ratios are shown in Table 8.

DISCUSSION

Overall results

This study confirms that it is possible for good surgical outcomes to be achieved in an eye hospital in Africa. Over 80% of eyes had a best corrected vision of 6/18 or better at 2 months. Although this is encouraging, it still falls short of the WHO guideline of 90%. This guideline may be ambitious for a third world environment, given that only 89% of Australians

Table 7 Causes of poor outcome (best corrected acuity <6/60) in 1210 eyes seen at 2 month follow up

Cause of poor outcome	No of eyes	% of eyes <6/60	% of eyes with follow up
Pre-existing eye disease	(16 eyes)		
COAG	5	16.1	0.41
Diabetic retinopathy	4	12.9	0.33
Macular hole	3	9.7	0.25
ARMD	3	9.7	0.25
Corneal opacity	1	3.2	0.08
Surgical complications	(10 eyes)		
Cystoid macular oedema	3	9.7	0.25
Retinal detachment	3	9.7	0.25
Bullous keratopathy	2	6.4	0.17
Others	2	6.4	0.17
Postoperative or unknown	(5 eyes)		
Other causes	5	16.1	0.41
Total	31		

who had cataract surgery were able to see 6/18 with best corrected vision.[7] Despite the use of biometry and intraocular lenses selected for emmetropia, only 44% had an uncorrected vision of 6/18 or better at 2 months. This is presumably because many patients were myopic following surgery, with a mean spherical equivalent of −1.5. In addition, the majority had at least 2 dioptres of astigmatism at 2 months. A trial of ECCE and phacoemulsification in the United Kingdom showed that only 19% of ECCE patients achieved an unaided acuity of 6/9 or better by 3 months, compared to 35% of phacoemulsification eyes.[13] This was because of the higher levels of astigmatism in the ECCE group, which also averaged between 2 and 2.5 dioptres at 2 months. At Kikuyu, biometry was carried out by nurses, and there appears to have been a systematic overestimation of the power of IOL required for emmetropia, possibly because of inaccurate measurement of the length of the eye. Improved accuracy of biometry might reduce the number of patients requiring spectacles, but reducing postoperative astigmatism would have an even greater effect. Possibly the use of sutureless ECCE and PC-IOL techniques might lead to additional improvements in uncorrected acuity[14]

Approximately 40% of patients still required glasses in order to achieve good vision. As many patients will not use glasses, because they cannot afford them, because the glasses are lost or broken, or because they have satisfactory vision in the other eye without glasses, it is likely that a population based study of presenting acuity, in the same patients, would find worse outcomes.

Non-physician cataract surgeons

This study was not designed to detect differences in outcomes between different cadres of eye worker. Non-physician cataract surgeons operated only on uncomplicated cataracts in which a good outcome was expected. Patients with more complex pathology had their surgery performed by an ophthalmologist. However, our results suggest that, with appropriate training, supervision, and case selection, non-physician cataract surgeons can achieve acceptable results with ECCE and PC-IOL. It is therefore recommended that where non-physicians are taught cataract surgery, their training should emphasise ECCE and PC-IOL..

Comorbidity and comparison with United Kingdom

As expected, there are significant differences between patients undergoing cataract surgery in Africa and in Europe. In the National Cataract Surgery Survey, over 30% of eyes undergoing surgery in the United Kingdom had a preoperative vision of 6/18 or better.[15] Only 0.5% of eyes operated at Kikuyu Eye Unit had this level of acuity. An unexpected finding was the high prevalence (10.9%) of known diabetes in our patients. This is very similar to the prevalence in cataract patients in the United Kingdom,[15] despite the older age of UK patients, and the greater probability of diabetes being diagnosed in a wealthy country's healthcare system. Ocular comorbidity was known to be present in 28% of cataract patients in the United Kingdom,[15] compared to 8.2% of patients at Kikuyu. This is partly due to the greater frequency of mature cataract in Africa. If the fundus cannot be visualised, it is difficult to make a preoperative diagnosis of age related macular degeneration. The lack of primary eye care means that conditions such as amblyopia may be unrecognised. The true prevalence of ocular comorbidity in our cataract patients is likely to be higher than 8.2%.

The reduction in the number of patients with comorbidity is open to different interpretations. As the largest cause of poor outcome is pre-existing pathology, unless case selection improves, there can only be a small reduction in the number of unfavourable visual results. In this study, the number of patients with poor outcomes was too small to show a change in the proportion as a result of pre-existing eye disease. There is no evidence to prove that operating on fewer patients with other eye problems equates to better case selection, but we do know that the presence of comorbidity was strongly associated with a poor outcome. Stricter case selection may mean that some patients who would benefit from cataract extraction are denied surgery, and it is important to strike an appropriate balance between helping as many people as possible, and obtaining the best possible results. In any event, the decline in the proportion of patients with other eye problems is only partly responsible for the improvement in outcomes. If all patients with comorbidity are excluded from the analysis, the results of surgery are still significantly better at the end of the year than at the beginning.

Follow up

Although 67% follow up is less than would be expected from a similar study in a developed country, it represents a high figure for Africa, particularly as no incentives were offered to encourage patients to return.[16] Diabetic patients were slightly more likely to return for follow up, possibly because some of them were already attending regularly for detection and treatment of diabetic retinopathy. Apart from this, there appeared

Table 8 Risk factors for poor outcome (<6/60 best corrected acuity at 2 months)

			Odds ratio		
	6/6–6/60	<6/60	OR	95% CI	p Value
All eyes	1141	31			
Vitreous loss	58	9	9.70	3.97 to 23.68	<0.001
Diabetes	130	10	4.58	1.96 to 10.74	0.001
Ocular comorbidity	85	9	4.53	1.93 to 10.63	0.002
Blind (<3/60 both eyes preop)	244	14	3.96	1.83 to 8.57	0.001
Age >80	120	10	3.39	1.40 to 8.17	0.01

Odds ratios calculated by stepwise multiple logistic regression.

to be no major differences between those patients who returned for follow up at 2 months and those who did not, in particular there were no differences in comorbidity and operative complication rates.

Risk factors for poor outcome

The risk factors for poor outcome are similar to the findings of the UK National Cataract Survey.[8] The majority of poor outcomes were related to pre-existing, and usually undetected, ocular comorbidity. Blind patients were at greater risk of poor outcome. This is likely to be related to the high prevalence of comorbidity in blind patients. It is probable that at least some of the blind patients who had cataract extraction would not have been offered surgery if their other eye had better vision.

Late complications

We did not find any cases of postoperative endophthalmitis. Although the study was not large enough to obtain reliable data about such a rare complication, it does show that high standards of sterility and theatre management are achievable in a developing country. The incidence of retinal detachment was slightly higher than that observed in the United Kingdom.[8]

Monitoring outcome

Although many authors have shown that the results of cataract surgery in third world countries are disappointing, to our knowledge this is the first study to document a significant improvement in outcomes over a 1 year period. Analysis of previously published data,[10] collected over 4 years, shows no evidence of seasonal variation in the outcomes at 2 months after surgery. There were no major changes in staffing, equipment, or surgical techniques during the year of the study.

In the absence of alternative explanations, it seems likely that the process of prospective monitoring has contributed to the improvement in outcomes. However, this was not a prospective randomised trial, and it is possible that the improvement in outcomes is the result of other confounding factors which we have not considered. As the staff at Kikuyu are already experienced surgeons, there was little change in the incidence of intraoperative complications. There appear to be two main reasons for the improvement in outcomes in our setting. Firstly, identification of vitreous loss as a risk factor for poor outcome led to discussion and additional training in the management of intraoperative complications. This resulted in significantly improved outcomes for patients whose surgery was complicated. Secondly, there was a steady and significant decrease in the number of patients with ocular comorbidity who had surgery. As pre-existing eye disease caused over half of the poor outcomes, improved case selection proved to be important in reducing the number of poor results. We suggest that the process of prospective monitoring may lead to a change in surgeons' attitudes, away from concentrating on the numbers of operations, towards consideration of both the quality and the quantity of cataract surgery.

Implications

This study has important implications for prevention of blindness from cataract globally. Introduction of prospective monitoring of outcomes at Kikuyu Eye Unit increased the proportion of good outcomes from 79% to 89% in 1 year. If a similar level of improvement is reproducible in other areas of the world, monitoring outcomes would result in an extra one million successful cataract operations per year at current service levels. The cost of the necessary computer hardware and software is less than £1500. For units performing 500 to 1500 cataract operations per year, introduction of prospective monitoring will cost £1 to £3 for every cataract operation in the first year. Thereafter, the cost is negligible.

Prospective standardised monitoring of cataract surgical outcomes with regular (every 100 cases) analysis of the causes of poor outcome is an important tool, which individual ophthalmic surgical teams can use to improve the results of their cataract surgery. The emphasis should be on continuous internal audit over time in order to improve results, rather than on inappropriate comparison of results between centres or surgeons.

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