Original Article

Outcomes of Cataract Surgery at a Referral Center

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Abstract

Purpose: To report the outcomes of cataract surgery at a large referral eye hospital and to identify factors associated with less than excellent visual outcomes.

Methods: Hospital records of patients, who had undergone age-related cataract extraction (1,285 procedures) within a two-year period were sampled randomly for 353 patients (405 eyes) and baseline characteristics were recorded. Up to three causes of visual loss (contributory reasons) were considered and the principal cause of "less than excellent outcome," i.e., best spectacle corrected visual acuity (BSCVA) <20/25 was defined as the primary reason.

Results: Mean age of the participants was 68.6 years, and 50.7% of enrolled subjects were female. Phacoemulsification had been performed in 92.1% of cases. Out of 405 eyes, 54%, 78%, and 97% achieved BSCVA of ≥20/25, ≥20/40, and ≥20/200, respectively. Poor visual outcomes were significantly associated with older age (OR: 4.55 for age >70 years), female gender (OR: 4.64), ocular comorbidities (OR: 7.68), surgically challenging eyes (OR: 7.33), long and short eyes (versus eyes with normal axial length, OR: 3.24), and being operated on by a novice surgeon (OR: 2.41). The leading contributory reasons for unfavorable outcome, in descending order were maculopathy (17%), posterior capsule opacification (PCO, 11.8%), corneal opacity (5.7%), and degenerative myopia (5.4%).

Conclusion: Maculopathy, PCO, corneal opacity, degenerative myopia and ARMD may contribute to unfavorable outcomes in cataract surgery.

Keywords: Cataract Surgery; Outcome; Phacoemulsification

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INTRODUCTION

Cataract is the leading cause of treatable blindness worldwide and 75% of people with cataracts live in developing countries where blindness is associated with considerable disability, and major economic and social consequences.[1-3] Recent population-based reports from several developing countries show that 21-50% of people who have had cataract surgery have presenting visual acuity (VA) <6/18 in the operated eye, and 11-23% have <6/60 VA.[4-11]

It has been suggested that surgical outcome in developing countries is noticeably poorer than those of

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developed countries.[12,13] Studies have pointed to factors, including patient selection and visual potential, cataract surgery technique and intraoperative events, and postoperative care as contributors to the outcome.[14,15]

Herein, we report the outcomes of cataract surgery at a university based eye hospital in the capital of Iran, Tehran. The factors and reasons for a 'less than excellent' outcome in that setting were analyzed.

METHODS

Settings

The study was conducted at Farabi Eye Hospital, a university-affiliated hospital, and the largest eye referral center in Northern Iran; the study protocol was approved by the Institute Review Board. This hospital has an annual volume of about 33,000 surgical procedures of which >13,000 are cataract procedures. Corresponding annual patient visits are >300,000.

Out of 6,701 patients aged over 50 years who underwent cataract surgery within a two-year period (2006-2007), 1,285 records were randomly selected and baseline characteristics were documented. Patients were recruited for an outcome visit from this pool, and when the intended sample reached >350 patients (400 eyes), sampling was terminated. Participants from the randomly selected pool were assessed for the study. Further aspects of sampling and participant flow have been reported elsewhere.[16]

Baseline data and surgical details, including biometry were extracted from the records, alongside preoperative and surgical examination sheets. A current medical history was taken and an ophthalmic examination, including refraction, slit lamp biomicroscopy, Goldmann applanation tonometry and posterior segment examination, was comprehensively updated. Ocular comorbidities and sequelae of surgical complications were sought in the records and during the outcome visit. Participants were provided with refraction, suture removal and YAG laser capsulotomy (in case of visually significant posterior capsule opacification, PCO). Further advice was given and prudent follow-up was planned for ocular comorbidities.

Five qualitative categories were considered for visual acuity (VA): Excellent (≥20/25); satisfactory (20/40 to <20/25); acceptable (20/100 to <20/40); borderline (20/200 to <20/100); and poor (≤20/200). The cut-offs were reached based on literature review,[17] and expert opinion. A standardized scheme was used to explain any visual loss. Best spectacle-corrected VA (BSCVA) <20/25 was defined as "less than excellent outcome". During the study, up to three causes of visual loss were listed in descending order regarding their perceived role in visual loss. The principal cause of less than excellent outcome was defined as the primary reason.

Axial length was categorized as short (<22 mm), normal (22-24.5 mm), and long (>24.5 mm). Ocular comorbidities were subcategorized into "surgically challenging eyes" (including pseudoexfoliation syndrome (PXF), phacodonesis, miotic pupil and corneal opacity) and eyes with "guarded visual potential" (including age-related macular degeneration [ARMD], glaucoma, vision-threatening diabetic retinopathy, corneal opacity, and degenerative myopia). A "novice surgeon" category defined junior residents.

Statistical Analysis

Despite the conversion of VA data into logMAR notations, BSCVA data did demonstrate normal distribution (Kolmogorov-Smirnov test, $P < 0.001$), and non-parametric tests were used. The Mann-Whitney U-test was used to assess associations between BSCVA and sex, systemic comorbidities, ocular comorbidities, cataract maturity, surgeon competence, surgical approach (temporal, or superior), incision type (corneal, or scleral), anesthesia, and surgery timing. The Kruskal-Wallis test was used to assess relationships between BSCVA and age groups, axial length categories and surgical technique.

RESULTS

The participation rate for the study was 51%. Baseline and surgical characteristics of responsive and non-responsive subjects were compared which revealed that the participants were actually representative of the randomly selected pool in terms of the study variables. These included female gender (participants vs. non-participants: 49.9% vs. 53.6%), phacoemulsification rate (92.8% vs. 90%), mean age at surgery (68.6 vs. 69.3 years), mature cataract rate (13.6% vs. 14.7%), intraocular lens power (19.70 D vs. 19.74 D), vitreous loss rate (1.7% vs. 2%), and aphakia rate (0.5% vs. 1%), respectively.

Of 353 cataract operated participants (405 eyes), 179 patients (50.7%) were female (203 eyes). Mean age at surgery was 68.6 ± 9.2 years. The cataract extraction technique included phacoemulsification (92.1%), small incision cataract surgery (SICS, 3.7%) and extracapsular cataract extraction (ECCE, 4.2%). More than half of the eyes (53.8%) had an excellent outcome (BSCVA ≥20/25) and close to 80% had a BSCVA of 20/40 or better. Only 2.8% of the eyes (n = 11) had BSCVA <20/200. Mean values for BSCVA and uncorrected visual acuity (UCVA) following cataract surgeries were 0.22 and 0.35 logMAR, respectively.

Postoperative BSCVA Determinants

Age, gender, and systemic conditions

Visual outcome and age were inversely correlated; mean age at the time of surgery was 71.6 years in cases with a poor visual outcome vs. 66.3 years in subjects with an excellent outcome ($P < 0.001$). Male patients achieved better BSCVA than female counterparts (median: 0.07 vs. 0.15 logMAR, $P < 0.001$). 'Excellent' vision was achieved in 63.1% of male cases vs. 44.7% of female subjects ($P < 0.001$). Systemic conditions, including hypertension, hyperlipidemia, ischemic heart disease and diabetes mellitus were present in 220 (54.3%) of eyes, but none of these conditions were significantly association with BSCVA ($P = 0.65$) [Table 1].

Table 1. Visual outcome, based on BSCVA and associated factors

Parameter (%)	Excellent ≥20/25 (*n*=211, 53.8%)	Satisfactory 20/25> to ≥20/40 (*n*=97, 24.7%)	Acceptable 20/40> to ≥20/100 (*n*=59, 15.1%)	Borderline 20/100 >to ≥20/200 (*n*=14, 3.6%)	Poor 20/200> to ≥20/400 (*n*=11, 2.8%)	BSCVA (mean)	BSCVA (median)	*P*†
Age								
50-59	72 (70.6)	16 (15.7)	12 (11.8)	2 (2)	0	0.1	0.02	<0.001
60-69	68 (49.6)	41 (29.9)	21 (15.3)	4 (2.9)	3 (2.2)	0.21	0.12	
70-79	61 (48.8)	32 (25.6)	20 (16)	5 (4)	7 (5.6)	0.28	0.12	
>80	10 (35.7)	8 (28.6)	6 (21.4)	3 (10.7)	1 (3.6)	0.35	0.28	
Mean (years)	66.34	68.65	69.73	70.27	71.59	0.22	0.1	
Gender								
Female	88 (44.7)	53 (26.9)	40 (20.3)	7 (3.6)	9 (4.6)	0.28	0.15	<0.001
Male	123 (63.1)	44 (22.6)	19 (9.7)	7 (3.6)	2 (1)	0.15	0.07	
Systemic comorbidities††	118 (55.7)	49 (23.1)	34 (16)	6 (2.8)	5 (2.4)	0.21	0.07	0.65
Ocular comorbidity								
Surgically challenging eye*	22 (37.9)	12 (20.7)	15 (25.9)	3 (5.2)	6 (10.3)	0.39 versus 0.18	0.2 versus 0.07	0.002
Guarded visual potential**	12 (12.9)	30 (32.3)	33 (35.5)	8 (8.6)	10 (10.8)	0.51 versus 0.12	0.35 versus 0.05	<0.001
Axial length								
Short	9 (29)	10 (32.3)	9 (29)	2 (6.5)	1 (3.2)	0.34	0.3	<0.001
Normal	195 (59.1)	82 (24.8)	38 (11.5)	8 (2.4)	7 (2.1)	0.17	0.07	
Long	6 (20)	5 (16.7)	12 (40)	4 (13.3)	3 (10.0)	0.59	0.43	
Mature cataract rate	29 (54.7)	12 (22.6)	9 (17)	1 (1.9)	2 (3.8)	0.23	0.1	0.49
Surgeon competence								
Experienced	191 (55.2)	85 (24.6)	49 (14.2)	13 (3.8)	8 (2.3)	0.2	0.08	0.01
Novice	20 (43.5)	12 (26.1)	10 (21.7)	1 (2.2)	3 (6.5)	0.32	0.15	
Surgical routines								
Technique								
Phacoemulsification	199 (54.4)	91 (24.9)	54 (14.8)	14 (3.8)	8 (2.2)	0.21	0.1	0.68
SICS	6 (42.9)	4 (28.6)	3 (21.4)	0	1 (7.1)	0.3	0.14	
ECCE and "converted"	6 (50)	2 (16.7)	2 (16.7)	0	2 (16.7)	0.36	0.13	
Approach								
Temporal	192 (53.9)	87 (24.4)	54 (15.2)	14 (3.9)	9 (2.5)	0.21	0.1	0.55
Superior	19 (52.8)	10 (27.8)	5 (13.9)	0	2 (5.6)	0.23	0.1	
Incision								
Corneal	173 (58.1)	67 (22.5)	42 (14.1)	10 (3.4)	6 (2)	0.19	0.07	0.004
Scleral (including limbal)	38 (40.4)	30 (31.9)	17 (18.1)	4 (4.3)	5 (5.3)	0.3	0.19	
Anesthesia (local)	188 (53.9)	90 (25.8)	51 (14.6)	11 (3.2)	9 (2.6)	0.21	0.1	0.32
Surgery in the afternoon	145 (54.3)	68 (25.5)	36 (13.5)	11 (4.1)	7 (2.6)	0.21	0.1	0.22

†Calculated based on LogMAR visual acuity; ††Including HTN, HLP, DM, and IHD; *Including pseudoexfoliation, phacodonesis, miotic pupil and corneal opacity; **Including age-related macular degeneration, glaucoma, vision threatening diabetic retinopathy, corneal opacity and degenerative myopia. ECCE, extracapsular cataract extraction; SICS, small incision cataract surgery; LA, local anesthesia, HTN, hypertension; HLP, hyperlipidemia; IHD, ischemic heart disease; DM, diabetes mellitus; BSCVA, best spectacle-corrected visual acuity

Ocular comorbidities, axial length, and mature cataract

Out of 405 eyes, 119 (29.4%) had ocular comorbidities including ARMD (n = 35, 8.6%), vision-threatening diabetic retinopathy (n = 11, 2.7%), glaucoma (n = 21, 5.2%), corneal opacity (n = 31, 7.7%) and degenerative myopia (n = 21, 5.2%). Eyes with guarded visual potential had lower median BSCVA than others (0.35 vs. 0.05 logMAR, $P < 0.001$). Surgically challenging eyes similarly had lower median BSCVA (0.2 vs. 0.07 logMAR, $P = 0.002$). An excellent outcome (BSCVA ≥ 20/25) was achieved in 37.9%, and 12.9% of surgically challenging eyes and those with guarded visual potential, respectively.

An excellent outcome was achieved in 65% of eyes with none of these problems ($P < 0.001$). Median BSVCA for long, short and normal-sized eyes were: 0.3, 0.43 and 0.07 logMAR, respectively ($P < 0.001$). There was no significant association between cataract maturity and BSCVA ($P = 0.49$).

Surgeon competence and surgical routines

Close to 66% (269) of eyes were operated by highly skilled surgeons. Being operated by a novice, rather than an experienced cataract surgeon, was associated with worse visual outcome (median BSCVA 0.15 vs. 0.08 logMAR, $P = 0.01$), and more vitreous loss (3.64 vs. 1.43%, $P = 0.01$). There were no significant relationship between treatment modalities, surgical approach (temporal *vs*. superior), type of anesthesia, or surgery timing and BSCVA. However, eyes with corneal incisions had better BSCVA (0.07 vs. 0.19 median logMAR, $P = 0.004$) [Table 1].

Contributing and Primary Causes of Postoperative BSCVA <20/25

Contributory reasons for less than excellent outcomes were maculopathy (17%, n = 68), PCO (11.8%), corneal opacity (5.7%) and degenerative myopia (5.4%) [Table 2]. The three most common primary causes of less than excellent outcome are listed in Table 3. Corneal opacity, dry ARMD, PCO and maculopathy were the most common conditions causing poor, borderline, acceptable and satisfactory BSCVA, respectively.

Postoperative UCVA

Out of 405 operated eyes, 31% (122 eyes) had UCVA >20/25. Only 5.6% of eyes (n = 22) had UCVA <20/200. Satisfactory (≥20/40 to <20/25), acceptable (≥20/100 to <20/40) and borderline (≥20/200 to <20/100) UCVA outcomes were achieved in 31.7% (n = 125), 25.1% (n = 99), and 6.6% (n = 26) of eyes, respectively. UCVA data and refractive aspects were analyzed and have been reported elsewhere.[16] Subjective satisfaction was close to 80% in the participants.

Table 2. Distribution of contributory causes (anatomically organized) for less than excellent visual outcome (BSCVA <20/25) in patients after cataract surgery

Contributory cause	*n* (%)
Corneal	
Opacity	23 (5.7)
Irregular astigmatism	8 (2)
IOL (subluxation and/or tilt)	9 (2.2)
PCO	48 (11.8)
Retinal	
ARMD	15 (4)
Diabetic retinopathy	12 (3)
Degenerative myopia	22 (5.4)
Maculopathy (nonspecific pigmentary changes (presumably a resolved macular edema following posterior capsule rupture), epiretinal membrane, macular hole, attached retinal detachment, etc.)	68 (17)
Glaucoma	10 (2.5)
Optic nerve	
Atrophy	9 (2.2)
Dysplasia	5 (1.2)
Glaucoma	10 (2.5)
Undetermined	
Presumed amblyopia	12 (3)
Remained "unexplained"	7 (1.7)

No endophthalmitis was documented. BSCVA, best spectacle corrected visual acuity; IOL, intraocular lens; PCO, posterior capsule opacity; ARMD, age-related macular degeneration

Postoperative complications

Seventy-two eyes (17.7%) developed complications. Seven eyes (1.7%) had posterior capsule rupture (95% CI, 1.6-1.8%), and eight eyes (2%) had retained sutures. Bullous keratopathy was found in one eye, and one patient was operated for pseudophakic retinal detachment. A visually significant PCO was found in 13.1%, including eyes that had already undergone capsulotomy.

DISCUSSION

In the current series, more than 78% of operated eyes had postoperative BSCVA of 20/40, or better, and only 2.8% had BSCVA worse than 20/200. Although the current study is a hospital-based study, the results are comparable to previously reported postoperative visual acuities from large studies in the United States, Canada, Denmark, Spain, United Kingdom and Sweden,[18-22] and remarkably better, with lower complication rates than those in developing countries.[12] This difference may be attributed to our hospital-based setting and the fact that most procedures (>90%) employed phacoemulsification, analogous to developed countries, which is known to be associated with better outcomes. There has been a well-established transition into phacoemulsification in Iran[23] but SICS and ECCE are still the preferred methods

Table 3. Top three primary reasons for less than excellent visual outcome (BSCVA <20/25) (*n*)

	Poor (20/200> to ≥20/400)	Borderline (20/100> to ≥20/200)	Acceptable (20/40> to ≥20/100)	Satisfactory (20/25> to ≥20/40)
First reason	Corneal opacity (4)	Dry ARMD (4)	PCO (12)	Maculopathy (38)
Second reason	Degenerative myopia (3)	Unexplained (3)	High myopia (9)	PCO (20)
Third reason	Dysplastic disc (1)	Corneal opacity (2)	Corneal opacity (8)	Diabetic retinopathy (6)

BSCVA, best-spectacle corrected visual acuity; ARMD, age-related macular degeneration; PCO, posterior capsule opacity

of cataract surgery in many developing countries,[24] owing to cost and a technological gap. Despite the university affiliation of our hospital, most eyes (66.4%) were treated in the non-educational service by experienced phacoemulsification surgeons, and operations in the educational setting were supervised by the faculty.

BSCVA of 6/18 (equivalent to 20/60), or better has been recommended by the World Health Organization (WHO), as indicative of good visual outcome following cataract surgery,[17] but advances in cataract surgery, and parallel changes in patient expectations warrant setting higher cut-offs; for instance, in this study BSCVA ≥20/40 was achieved in about 80% of operated eyes, while over half of the eyes achieved ≥20/25. We believe that UCVA ≥20/40 and BSCVA ≥20/25 provide better cut off values for studying the outcome of cataract surgery in future studies.

Older age and a female gender have been associated with less satisfactory visual outcomes following cataract surgery,[25-27] as also observed in this study. This issue has addressed elsewhere in a comprehensive manner.[28]

Eyes with ocular comorbidities (PXF, corneal opacity, glaucoma, visually significant diabetic retinopathy, ARMD, and degenerative myopia) which were denoted as "surgically challenging eyes," or eyes with "guarded visual potential" had significantly poorer BSCVA which is consistent with previous reports.[10,15,17] Forooghian et al showed that eyes without ARMD gained 8.4 letters of acuity, but eyes with advanced ARMD gained 1.9 letters. This implies that even patients with ARMD may benefit from cataract surgery.[29,30] Cataract surgery in PXF is known to be associated with more complications.[30,31] In this study, eyes with PXF had poorer outcome; this could be due to a glaucomatous status, or anterior segment features that made the surgery challenging. However, some studies suggest that with suitable preoperative preparation, intraoperative use of appropriate devices, and suitable follow-up, good outcomes can also be achieved in eyes with PXF.[32]

The influence of axial length has been reported in previous studies.[33] In our series, eyes with axial length <22 mm, or >24.5 mm had substantially less satisfactory outcomes [Table 1]. High axial length correlates with degenerative myopia which reduces visual potential. The poorer outcome in short-eyes may be explained by the high frequency of amblyopia in such eyes.

The effect of surgeon competence, specifically regarding phacoemulsification has already been reported,[30,34] and was replicated in this study [Table 1]. The difference might have been underestimated, as more challenging cases (with guarded status) were more frequently operated by experienced surgeons. There is an opportunity to improve outcomes through better supervision, and transfer of skills in phacoemulsification. This challenge is specifically relevant to developing countries still in transition to phacoemulsification.

Due to the small size of ECCE and SICS subgroups, their outcomes could not be compared with phacoemulsification. Although, incision site had a significant association with BSCVA, this finding is likely a coincidence rather than a cause.

Except diabetes mellitus (accompanied by vision-threatening diabetic retinopathy), systemic comorbidities were not associated with poor visual outcomes and hence cataract patients with systemic problems can benefit equally from cataract surgery. Cataract maturity also did not adversely affect postoperative BSCVA.

This study substantiates the importance of patient selection in cataract surgery.[22,35]

Based on the observations of this study and regarding advances in cataract surgery, a change is recommended from "patient selection" to the concept of "patient counseling and surgical planning". Therefore, vision improvement alongside with patient expectations should be addressed. Also a suitable level of resources should be provided to handle the eyes with a surgically challenging status.

Twelve distinct reasons were listed in Table 2 for visual loss in these patients. The five leading contributory factors for less than excellent outcome in descending order were: Maculopathy, PCO, corneal opacity, degenerative myopia and ARMD. PCO and corneal opacity have consistently been reported as causes of visual loss in cataract-extracted eyes.[36,37] PCO is recognized as the most common complication of cataract surgery; untreated PCO existed in about 12% of operated eyes. It is believed that patients should be informed about this long-term complication and encouraged to seek follow-up care. PCO in the data set has been extensively described elsewhere.[38,39] Corneal opacity is a common finding in senior citizens of developing countries.[40] In the current series is was listed among the top three

primary reasons for poor visual outcome [Table 3]. Corneal opacity is frequently a result of cicatricial trachoma. But, other infectious causes, like childhood viral infections and interstitial keratitis, along with vitamin-A deficiency may contribute to the condition.

Choosing a BSCVA cut off value of >20/25 caused emergence of maculopathy, as the major cause of impaired vision in the range of 20/40 to 20/25 [Table 3], and other categories of impaired vision in general [Table 2]. Maculopathy covers distinct diagnoses such as macular hole and epiretinal membrane, and non-specific pigmentary changes which were common because of resolved cystoid macular edema, old trauma (resolved Berlin's edema), resolved central serous chorioretinopathy, eclipse retinopathy, old retinal detachment, etc.

The major cause of visual loss in cataract extracted eyes varied according to the degree of visual loss;[41] the following approximate inferences could be made: Mild maculopathy and PCO cause mild visual loss; corneal opacity causes moderate visual loss; and degenerative myopia, dysplastic disc and ARMD cause severe visual loss [Table 3].

Our observations should be generalized cautiously, as many patients in the selected sample were not reachable, deceased, or noncompliant, and also because the setting was hospital-based. However, since the study center is a major public referral hospital, a wide spectrum of simple to complicated cataract surgery candidates was represented. The educational setting and the surgeon mix add a new dimension, i.e., competence variation, which further expands the scope of the study.

In summary, our results suggest that with suitable knowledge transfer and skill acquisition, the outcomes of cataract surgery, including phacoemulsification, could be as desirable as that in developed nations. Surgically challenging eyes and eyes with guarded visual potential (e.g., pseudoexfoliation syndrome or corneal opacity), and eyes operated on by novice surgeons had poorer outcomes. In this study, the five leading factors contributing to less than excellent outcome, in descending order, were maculopathy, PCO, corneal opacity, degenerative myopia and ARMD, which cause mild, moderate, and severe visual loss, respectively.

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Conflicts of Interest

There are no conflicts of interest.

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