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# Visual acuity outcomes after cataract surgery in type 2 diabetes: the Action to Control Cardiovascular Risk in Diabetes (ACCORD) study

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## ABSTRACT

**Aims** To evaluate visual acuity (VA) outcomes of cataract surgery, and factors associated with good visual outcomes, among a population with diabetes.

**Methods** Participants with type 2 diabetes enrolled in The Action to Control Cardiovascular Risk in Diabetes (ACCORD) study and ACCORD-eye substudy. 1136 eyes of 784 ACCORD participants receiving cataract surgery during follow-up (2001–2014) were included. Of these, 362 eyes had fundus photographs gradable for diabetic retinopathy. The main outcome measure was the achievement of postoperative VA of 20/40 or better.

**Results** In the sample of 1136 eyes, 762 eyes (67.1%) achieved good visual outcome of 20/40 or better. Factors predictive of good visual outcome were higher level of educational attainment (college vs some high school, OR 2.35 (95% CI 1.44 to 3.82)), bilateral cataract surgery (OR 1.55 (1.14 to 2.10)) and preoperative VA (20/20 or better vs worse than 20/200, OR 10.59 (4.07 to 27.54)). Factors not significantly associated ( $p > 0.05$ ) included age, sex, race, smoking, diabetes duration, blood pressure, lipid levels and haemoglobin A1C (HbA1C). In the subsample of 362 eyes, absence of diabetic retinopathy was associated with good visual outcome (OR 1.73 (1.02 to 2.94)).

**Conclusion** Among individuals with diabetes, two-thirds of eyes achieved good visual outcome after cataract surgery. Notable factors associated with visual outcome included preoperative VA and diabetic retinopathy, but not HbA1C, underscoring that while certain ocular measures may help evaluate visual potential, systemic parameters may not be as valuable. Sociodemographic factors might also be important considerations. Although the current visual prognosis after cataract surgery is usually favourable, certain factors still limit the visual potential in those with diabetes.

for worse visual outcomes included pre-existing diabetic retinopathy and macular oedema.<sup>8 9</sup>

In recent years, major developments have occurred in cataract surgery, the treatment of diabetic retinopathy and the management of diabetes. Newer surgical techniques (eg, small-incision phacoemulsification) have been associated with improved postoperative outcomes.<sup>9</sup> Superior imaging modalities and modern laser treatments have enhanced the management of diabetic retinopathy.<sup>10 11</sup> Recommendations for tighter glycaemic and blood pressure control have decreased the risk of diabetic complications.<sup>12 13</sup> These advances may have improved the potential for good visual outcomes after cataract surgery in individuals with diabetes. However, very few large-scale studies have evaluated the visual outcomes of people with diabetes after cataract surgery.

The Action to Control Cardiovascular Risk in Diabetes (ACCORD), a randomised controlled trial studied the effects of various medical interventions on cardiovascular outcomes in participants with type 2 diabetes. In the ACCORD population, the current study aimed to (1) analyse visual outcomes after cataract surgery and (2) identify predictors of good visual outcome in individuals with diabetes.

## MATERIALS AND METHODS

This was a retrospective case–control study of patients enrolled in the ACCORD and ACCORD-eye substudy. The main study and ancillary eye study (ClinicalTrials.gov identifiers NCT00000620 and NCT00542178) protocols were approved by the institutional review boards at their respective coordinating centres and each clinical centre. The study was conducted in accordance with the principles of the Declaration of Helsinki and complied with the Health Insurance Portability and Accountability Act. Signed informed consent was obtained from each participant for all trials.

## Study population

**ACCORD Study (2001–2009).** The study designs of the ACCORD and ACCORD-eye studies have been described previously.<sup>14 15</sup> In brief, the ACCORD study was a double 2×2 factorial, multicentre, randomised clinical trial studying the effects of intensive glycaemic control, intensive blood pressure control and/or treatment of dyslipidaemia with fenofibrate on cardiovascular events in patients with type 2 diabetes. From January 2001 to October

## INTRODUCTION

Cataract extraction is one of the most frequently performed ambulatory procedures, and its incidence continues to increase.<sup>1 2</sup> The prevalence of diabetes mellitus has also risen and is projected to reach 33% of the US adult population by 2050.<sup>3</sup> Individuals with diabetes have an increased risk of cataract development and subsequent need for cataract surgery. However, in older publications principally from the 1990s, the visual outcomes after cataract surgery were reported to be less favourable in the presence of diabetes.<sup>4–7</sup> Commonly cited reasons



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2005, 10 251 participants with type 2 diabetes and at high risk for cardiovascular disease (CVD) were recruited at 77 clinical centres (aggregated within seven networks) across the US and Canada.

The ACCORD study participants were randomised to either intensive or standard glycaemic control (target haemoglobin A1C (HbA1C) <6.0% vs 7.0%–7.9%). Of the 10 251 participants in the ACCORD study, 4733 participants were additionally randomised to either intensive or standard blood pressure control (target systolic blood pressure <120 mm Hg vs <140 mm Hg). The remaining 5518 participants were randomised to fenofibrate (to reduce triglycerides and increase high density lipoprotein-cholesterol) or placebo, in the context of effective LDL-cholesterol control with simvastatin. The ACCORD study primary outcome was the first occurrence of a major CVD event (ie, a nonfatal myocardial infarction, nonfatal stroke or death from a cardiovascular cause). In addition to clinical data regarding CVD, self-reported eye-related data including cataract surgery, neodymium-doped yttrium aluminum garnet laser capsulotomy, any retinopathy and photocoagulation/vitreotomy for diabetic retinopathy were documented at each annual study visit. Participants were asked only whether these events had occurred since their last annual study visit, and not the date on which each event had occurred. Visual acuity (VA) was assessed in the nonophthalmic study clinics at study baseline and every 2 years thereafter with a standardised VA chart (Early Treatment Diabetic Retinopathy Study (ETDRS) chart). Participants were instructed to bring their current glasses with them and were assessed for VA using current refractive correction (ie, presenting VA (PVA)) reflecting participants' true day-to-day vision.

*ACCORD-Eye study (2003–2009)*. The ACCORD-Eye study investigated a subset of the ACCORD study participants for the effects of the three medical interventions on the progression of diabetic retinopathy. From October 2003 to March 2006, the ACCORD-Eye study recruited 3537 of the ACCORD study participants without a history of proliferative diabetic retinopathy (PDR) treated with laser photocoagulation or vitrectomy. Each clinical centre identified study ophthalmologists to conduct standardised eye examinations on all ACCORD Eye study participants at baseline and year 4. These examinations included a VA measurement conducted by a staff member with the method customarily used in that office using the patient's glasses; if VA was worse than 20/40, a pinhole was added. Colour fundus photographs of seven standard stereoscopic fields were also obtained and graded by masked evaluators at the Fundus Photograph Reading Center (University of Wisconsin, Madison) for the presence and severity of diabetic retinopathy. The severity of diabetic retinopathy was graded using the ETDRS Final Diabetic Retinopathy Severity Scale for individual eyes, and categorised into the following five levels using the International Clinical Diabetic Retinopathy Severity scale: none (<20), mild non-PDR (NPDR) (20), moderate NPDR (35–47), severe NPDR (53) and PDR (≥60).

### Study sample

The inclusion criteria for the current analysis were eyes that (1) underwent cataract surgery during the ACCORD study follow-up and (2) had both a preoperative VA recorded within 2 years prior to surgery and a postoperative VA recorded within 2 years after surgery. Eyes that were pseudophakic or aphakic at baseline were excluded. The preoperative and postoperative VA used were the closest documented VA prior to and following cataract surgery, respectively.

Within the study sample, a subset of eyes received fundus photographs graded for diabetic retinopathy (ie, eyes of ACCORD-Eye participants). All analyses conducted in this subsample included data on diabetic retinopathy, which was categorised by presence/absence and severity level.

### Primary outcome

In addition to analysing visual outcomes after cataract surgery, the current study aimed to examine the sociodemographic, systemic and ocular factors associated with a primary outcome of good visual outcome after cataract surgery. Good visual outcome was defined as postoperative VA of 20/40 or better.

### Statistical analysis

Repeated measures logistic regression was used to evaluate the association of the covariates with postoperative VA ≥20/40. The unit of analysis was the eye. Because some participants contributed both eyes to the analysis, the exchangeable correlation structure was used to account for correlation between both eyes of a person.

A list of covariates (online supplemental eTable 1) was examined for potential inclusion in the final model by means of the variable selection approach described herein. Cross-tabulation analyses were initially conducted to compare proportions and means for variables between the two groups, leading to the exclusion of several variables, particularly those with very low frequencies. Next, a series of univariate analyses were performed to examine the associations between the narrowed list of variables and the primary outcome. Those variables screened at  $p < 0.15$  were then used in the selection of a final multivariate regression model.<sup>16</sup> In a multistep process, variables were entered or removed from the model by comparing the QIC<sub>μ</sub> (quasi likelihood under the independence) between the model with the variable with the model without the variable.<sup>16</sup> The variables age (at cataract surgery) and sex were included in all models. Self-reported data on the presence/absence of any retinopathy were not included because fundus photograph data were thought to be more accurate (see next paragraph). The analyses were performed with variables obtained at study baseline, with exception of age at cataract surgery, and preoperative and postoperative VA.

This multivariate regression model was then applied to the subsample of eyes that received fundus photographs. In this analysis, the variable diabetic retinopathy (categorised by presence/absence) was added to the list of covariates, after which the associations between the covariates and the primary outcome were reevaluated. Analyses were conducted using SAS V.9.4 (SAS Institute, Cary, North Carolina, USA).

## RESULTS

### Description of study sample

From 2001 to 2009, the ACCORD study followed 10 251 participants with type 2 diabetes at high risk for CVD for a median of 5.0 years (IQR 4.1–5.7). Of the 17 774 eyes for which eye-related data and VA data were collected, 1816 eyes (10.8%) underwent cataract surgery during follow-up and, after applying the inclusion criteria, 1136 (62.6%) eyes of 784 participants remained in the sample for analysis. The demographic and clinical characteristics of the participants included in the analyses are shown in [table 1](#). The ocular characteristics of the eyes included in the analyses are shown in [table 2](#). A total of 680 eyes of 474 participants were excluded from the study sample, and the demographic/clinical and ocular characteristics for these

**Table 1** Baseline sociodemographic and clinical characteristics of participants in the study sample

Characteristic	Overall (n=784)
Age at randomisation, mean years±SD	65.6±6.3
Male sex, n (%)	458 (58.4)
Race, n (%)	
White	537 (68.5)
Black	115 (14.7)
Hispanic	47 (6.0)
Other	85 (10.8)
Highest level of education, n (%)	
Some high school	120 (15.3)
High school graduate	231 (29.5)
Some college	253 (32.3)
College graduate or more	180 (23.0)
Clinical centre network, n (%)	
Canada	131 (16.7)
Western	100 (12.8)
Minnesota/Iowa	113 (14.4)
Ohio/Michigan	146 (18.6)
Northeastern	77 (9.8)
Southeastern	109 (13.9)
Veterans affairs	108 (13.8)
Insurance coverage, n (%)	715 (91.2)
Smoking status, n (%)	
Current	66 (8.4)
Former	402 (51.3)
Never	316 (40.3)
Cardiovascular disease, n (%)	282 (36.0)
HbA1C, mean %±SD	8.3±1.0
Diabetes duration, mean years±SD	16.3±8.0
Medications, n (%)	
Oral hypoglycaemic agents	628 (80.1)
Insulin	368 (46.9)
Aspirin	477 (60.8)
Cardiovascular agents	80 (10.2)
Lipid-lowering agents	563 (71.8)
Bilateral cataract surgery, n (%)	500 (63.8)

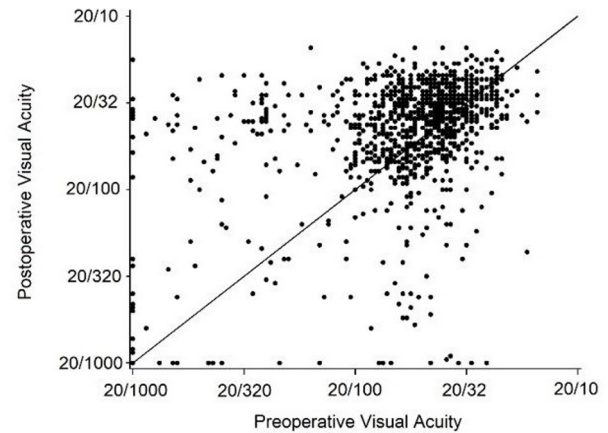
HbA1C, haemoglobin A1C.

participants and eyes are also shown in online supplemental eTables 2 and 3, respectively. Overall, individuals in the current study reported undergoing cataract surgery at a median time of 3.0 years (IQR 2.0–4.4) after randomisation. The median time from measurement of preoperative VA to report of surgery was 1.3 years (IQR 1.0–1.8), and the median time from report of

**Table 2** Baseline ocular characteristics of eyes in the study sample

Characteristic	Overall (n=1136)
Photocoagulation/vitreotomy, n (%)	161 (14.2)
Other eye surgery, n (%)	57 (5.0)
Pre-operative VA, n (%)	
<20/200	106 (9.3)
<20/40–20/200	505 (44.5)
<20/20–20/40	483 (42.5)
≥20/20	42 (3.7)

VA, visual acuity.

**Figure 1** Visual acuity scores before and after cataract surgery of eyes in the study sample (n=1136 eyes).

surgery to measurement of postoperative VA was 0.6 years (IQR 0.0–1.0).

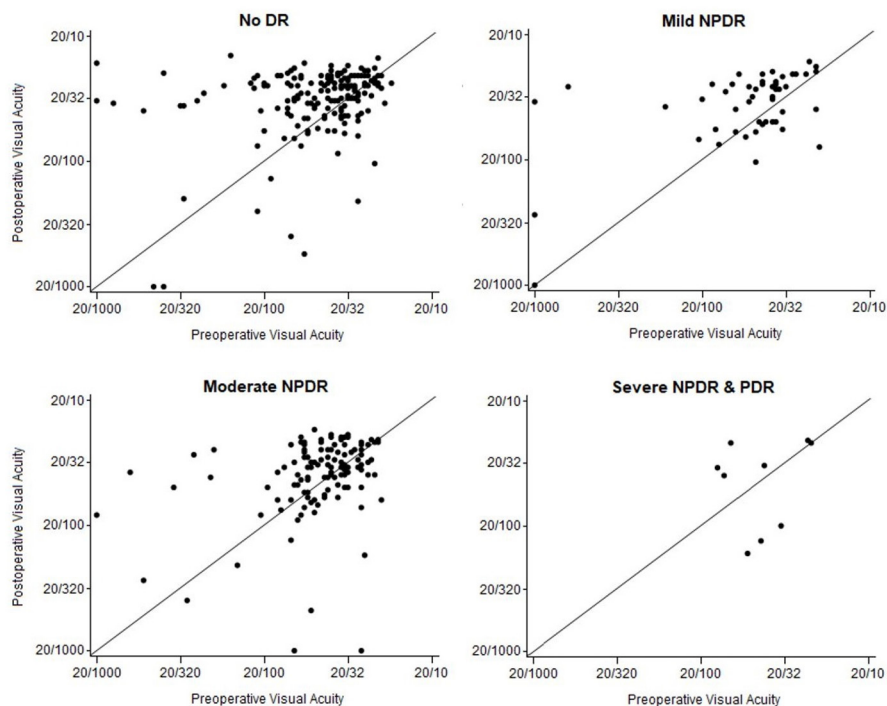
Of the overall sample, 362 eyes (31.9%) of 251 participants received fundus photographs gradable for diabetic retinopathy as part of the ACCORD-eye study. In this subsample, 179 eyes (49.4%) had no diabetic retinopathy, 50 eyes (13.8%) had mild NPDR, 124 eyes (34.3%) had moderate NPDR, 3 eyes (0.8%) had severe NPDR and 6 eyes (1.7%) had PDR. Among the ACCORD-eye subsample, there was a statistically significant difference between mean ( $\pm$ SD) presenting and pinhole VA scores ( $71.4 \pm 11.8$  letters (Snellen equivalent 20/40) and  $74.5 \pm 10.2$  letters (20/30),  $p < 0.001$ ). However, this three-letter difference is within the measurement error and is not clinically meaningful.

### Visual outcomes in individuals with diabetes

Overall, 762 eyes (67.1%) achieved a good visual outcome (ie, postoperative VA  $\geq 20/40$ ). The distribution of ocular variables of eyes that did versus did not achieve good visual outcomes are shown in online supplemental eTable 4. Among the subsample of eyes that received fundus photographs, 265 eyes (73.2%) achieved a good visual outcome. The distributions of preoperative and postoperative VA (and their relationships to each other at the individual eye level) for the overall sample are depicted in figure 1. The distributions according to severity of diabetic retinopathy for the subsample of eyes that received fundus photographs are shown in figure 2; they are also shown in a stratified tabular form in table 3. For the overall sample, the mean ( $\pm$ SD) in VA score after cataract surgery was  $+3.7 \pm 18.4$  letters. Analysis of the distribution showed 535 eyes (19.5%) had  $\geq 15$  letter improvement, 333 eyes (12.1%) had 14–10 letter improvement, 426 eyes (15.5%) had 9–5 letter improvement, 791 eyes (28.8%) had  $\pm 4$  letter change, 268 eyes (9.8%) had 5–9 letter worsening, 147 eyes (5.3%) had 10–14 letter worsening, and 248 (9.0%) had  $\geq 15$  letter worsening.

### Predictors of good visual outcome

The results of the multivariate repeated measures logistic regression are shown in table 4. The factors associated with good visual outcome were highest level of education (reference, some high school; highest, college graduate, OR 2.35 (95% CI 1.44 to 3.82)), clinical centre network (reference, Northeastern USA; highest, Veterans Affairs, OR 3.46 (95% CI 1.90 to 6.28)), preoperative VA (reference, <20/200; highest, 20/20+, OR 10.59 (95% CI 4.07 to 27.54)) and bilateral cataract surgery (OR 1.55 (95% CI 1.14



**Figure 2** Visual acuity scores before and after cataract surgery in the subsample of eyes that received fundus photographs (n=362 eyes), according to severity of diabetic retinopathy. PDR,proliferative diabetic retinopathy; NPDR,non-PDR.

to 2.10)). The variables race, insurance status, diabetes duration, HbA1C, lipid levels, blood pressure, insulin, lipid-lowering agents, time of cataract surgery (days from randomisation) and randomisation to medical treatments (eg, intensive glycaemic control) were not significant during the model selection.

The results of the multivariate repeated measures logistic regression for the subsample of eyes that received fundus photographs are shown in table 5. In this analysis, the factors associated with good visual outcome remained similar except for the inclusion of diabetic retinopathy and exclusion of clinical centre network from the model. Analysis by diabetic retinopathy severity did not show clear association between level of diabetic retinopathy and good visual outcome (reference, none; mild NPDR, OR 0.60 (95% CI 0.30 to 1.23), p=0.16; moderate NPDR, OR 0.58 (0.33 to 1.01), p=0.05; severe NPDR or PDR, OR 0.40 (0.09 to 1.85), p=0.24).

**DISCUSSION**

This is one of the largest studies to assess VA outcomes in people with diabetes undergoing cataract surgery. Furthermore, this study provides an updated benchmark of the prevalence of good visual outcome after cataract surgery in a contemporary

population with diabetes. Finally, the wealth of data on socio-demographic, systemic and ocular characteristics allows for an extensive investigation of predictors of good visual outcome after cataract surgery in diabetes.

**Table 3** Visual acuity scores before and after cataract surgery among the subsample of eyes that received fundus photographs (n=362), according to diabetic retinopathy severity

DR severity	Preoperative VA	Postoperative VA
None (n=179)	65.4±16.5 (20/50)	74.1±14.2 (20/33)
Mild (n=50)	62.7±20.4 (20/58)	71.1±15.5 (20/38)
Moderate (n=124)	65.9±14.6 (20/50)	69.6±15.6 (20/40)
Severe or PDR (n=9)	67.9±10.3 (20/46)	66.7±17.7 (20/48)
Total (n=362)	65.2±16.3 (20/50)	72.0±15.1 (20/36)

The results are listed as mean±SD VA letter score (Snellen equivalent). DR, diabetic retinopathy; PDR, proliferative diabetic retinopathy; VA, visual acuity.

**Table 4** Predictors of good visual outcome after cataract surgery in multivariate analysis of eyes in the study sample

Characteristic	OR (95% CI)	P value
Age at cataract surgery (per year)	1.00 (0.97 to 1.02)	0.91
Male sex	0.94 (0.69 to 1.27)	0.68
Highest level of education		0.006*
Some high school	1.00	
High school graduate	1.80 (1.17 to 2.76)	0.008
Some college	1.66 (1.07 to 2.57)	0.03
College graduate or more	2.35 (1.44 to 3.82)	<0.001
Clinical centre network		0.001*
Northeastern US	1.00	
Canada	1.72 (0.99 to 2.97)	0.05
Western US	2.16 (1.22 to 3.84)	0.09
Minnesota/Iowa	2.93 (1.60 to 5.35)	<0.001
Ohio/Michigan	2.25 (1.31 to 3.86)	0.003
Southeastern US	1.69 (0.96 to 2.99)	0.07
Veterans Affairs	3.46 (1.90 to 6.28)	<0.001
Preoperative VA		<0.001*
<20/200	1.00	
<20/40-20/200	1.65 (1.05 to 2.59)	0.03
<20/20-20/40	4.29 (2.69 to 6.83)	<0.001
≥20/20	10.59 (4.07 to 27.54)	<0.001
Bilateral cataract surgery	1.55 (1.14 to 2.10)	0.005

\*Overall p-values calculated for categorical variables with >2 levels. VA, visual acuity.

**Table 5** Predictors of good visual outcome after cataract surgery in multivariate analysis in the subsample of eyes that received fundus photographs.

Characteristic	OR (95% CI)	P-value
Age at cataract surgery (per year)	0.97 (0.93 to 1.01)	0.17
Male sex	1.20 (0.69 to 2.07)	0.53
Highest level of education		0.09*
Some high school	1.00	
High school graduate	2.26 (1.09 to 4.69)	0.03
Some college	2.28 (1.10 to 4.72)	0.03
College graduate or more	1.84 (0.86 to 3.91)	0.11
Preoperative VA		0.01*
<20/200	1.00	
<20/40-20/200	1.02 (0.38 to 2.70)	0.72
<20/20-20/40	2.38 (0.86 to 6.59)	0.04
≥20/20	2.39 (0.59 to 9.72)	0.23
Bilateral cataract surgery	1.78 (1.03 to 3.08)	0.04
Diabetic retinopathy		
Presence†	1.00	
Absence	1.73 (1.02 to 2.94)	0.04

\*Overall p-values calculated for categorical variables with >2 levels.

†Included mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR, and proliferative diabetic retinopathy (PDR).  
VA, visual acuity.

### Good visual outcome in individuals with diabetes

In the ACCORD study population, the rate of good visual outcome after cataract surgery was 67%. This suggests that the current visual prognosis after cataract surgery is usually favourable in those with diabetes. Prior studies have reported 62%–89% of individuals with diabetes achieve a good visual outcome (ie, VA of 20/40 or better on Snellen, or the equivalent VA notation).<sup>4–7 17–19</sup> However, most of these studies contained samples of fewer than 200 eyes, dated back more than 15 years and occurred at a single institution. By contrast, this study represents a large sample of a more recent population from multiple centres across the USA and Canada.

Individuals in this cohort may presumably have benefited from new clinical guidelines and medical developments, leading to better management of their disease and improved outcomes.<sup>10–13 20 21</sup> However, visual outcomes remained comparable to those previously reported, which may be due to several reasons. First, differences in the profile of patients, particularly in the prevalence and severity of diabetic retinopathy in each cohort, probably affected visual outcomes.<sup>22 23</sup> The current and prior studies reported rates of diabetic retinopathy prevalence at 51% and 29%–68%, respectively, though higher prevalence did not always correspond with poorer outcomes.<sup>4–7 17–19</sup> Second, variation in factors related to cataract surgery (eg, surgical techniques) or postoperative care (eg, macular oedema management) may also be important. Third, while prior studies measured best-corrected VA (BCVA), this study measured PVA to better reflect day-to-day functional vision. Visual impairment from uncorrected refractive error is a common condition in the USA, with rates higher in certain populations, including those with diabetes.<sup>24</sup> Despite advances in the refractive components of cataract surgery, differences between postoperative BCVA and PVA may remain if individuals in whom residual refractive error exists are left uncorrected.

In the context of these considerations, people with diabetes continue to achieve less favourable visual outcomes relative to the general population. Large national cataract surgery registries

show that 84%–91% of patients overall achieve postoperative BCVA of 20/40 or better, with this figure rising to around 95% in patients without ocular comorbidity.<sup>25 26</sup> Given this, our study indicates a continuing need to investigate the population with diabetes receiving cataract surgery and factors associated with visual outcome.

### Predictors of good visual outcome

Identifying factors associated with good visual outcome may help to predict VA after cataract surgery and to determine areas for further improvement. The current study investigates the role of several sociodemographic, systemic and ocular factors on visual outcomes in people with diabetes.

First, preoperative VA was a significant prognostic measure and may be valuable in the surgical evaluation for several reasons. Worse preoperative VA may indicate ocular comorbidities, either independent from (eg, amblyopia, macular or corneal disease) or as a secondary cause of (eg, anterior uveitis) cataract, that could limit visual potential after surgery. Reduced preoperative VA can also reflect a more advanced or dense cataract, which may increase the risk for intraoperative and postoperative complications (eg, capsular rupture, macular oedema) and impair postoperative VA.<sup>27 28</sup> Additionally, lower preoperative PVA can indicate inadequately corrected refractive error and an individual who may, thus, be unable to obtain or less likely to wear updated eyeglasses even after surgery.<sup>29</sup>

In patients with diabetes, this study suggests that the presence or absence of diabetic retinopathy is particularly important for visual outcomes. The severity of diabetic retinopathy could also be important, though this study did not have a large enough sample size to detect any significant effect. Several factors may be involved in the role of diabetic retinopathy. Diabetic retinopathy may limit postoperative VA through preexisting pathology, specifically macular ischemia, diabetic macular oedema (DMO) and/or proliferative disease. In eyes with diabetic retinopathy, cataract surgery can additionally precipitate DMO and may accelerate diabetic retinopathy progression, though evidence for the latter is less clear with phacoemulsification than with extracapsular extraction.<sup>30–32</sup> In evaluating the utility or timing of cataract extraction, these factors should be weighed against the benefits of better visualising the retina to monitor diabetic retinopathy.

In this study, systemic characteristics, notably HbA1C, were not significantly associated with achieving a good visual outcome. For individuals with diabetes, the issue of glycaemic control often raises concern due to delayed wound healing, increased infection and the risk for progression of diabetic retinopathy.<sup>12 33 34</sup> Consistent with prior reports, however, this study found that baseline HbA1C level was not a significant factor.<sup>22 23</sup> Though long-term systemic glycaemic control remains essential in diabetes management, with respect to visual outcomes after cataract surgery, an effect independent from that of the resulting diabetic eye disease may be less significant.

For patients with diabetes, social determinants of health influence clinical outcomes including diabetic retinopathy.<sup>35</sup> It may, thus, be important to consider the role of such factors for those undergoing cataract surgery. In the current study, visual outcomes were notably associated with clinical centre network and education level. These factors may serve as a proxy for socioeconomic status and be particularly significant in elucidating areas for improvement. For instance, among persons with diabetes and diabetic retinopathy, lower educational attainment has been linked to reduced access to and utilisation of eye care

services.<sup>35 36</sup> This is especially relevant for those undergoing cataract surgery, as easily correctable issues such as posterior capsular opacification and refractive error remain among the most common complications of cataract surgery.<sup>26 37</sup> A stronger emphasis on postoperative follow-up may be important in these individuals, and the impact of social factors on visual outcomes should not be overlooked.

### Limitations

There are several limitations to this study. First, the retrospective design may limit the ability to adjust for unknown confounding factors. Second, the use of clinical trial data may reduce generalisability of the results as trial participants often have higher levels of educational attainment, access to care and healthier behaviours, relative to the general population. Third, the infrequency at which VA was measured led to variation in the time intervals between the report of surgery and VA measurements and subsequently in the effects of various factors on outcome during these periods. Fourth, the infrequency at which surgery was reported led to variation in the time intervals between the reporting of and actual date of surgery and further contributed to variation in the effects of these factors on outcome. Fifth, the use of PVA may limit direct comparisons of the results from this study against those that used BCVA, though we consider PVA to be an important measure in itself. Sixth, this study could not specifically investigate the effects of DMO or antivasular endothelial growth factor injections on postoperative VA; future studies are necessary for examining the extent to which these factors impact the ability to achieve a good visual outcome after cataract surgery.

### CONCLUSION

Among individuals with diabetes, two-thirds of eyes achieved a good visual outcome of 20/40 or better, after cataract surgery. Despite new clinical guidelines and medical developments, this rate remained comparable to prior reports and lower than the general population. Notable factors associated with visual outcomes included preoperative VA and diabetic retinopathy, but not HbA1C, underscoring that while certain ocular measures may help to evaluate visual potential, systemic parameters may not be as valuable. Socioeconomic status and related issues may also be important considerations. Although the current visual prognosis after cataract surgery is usually favourable, certain factors still limit the visual potential in those with diabetes and continued efforts to improve visual outcomes are necessary.

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**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data may be obtained from a third party and are not publicly available. Action to Control Cardiovascular Risk in Diabetes (ACCORD)<https://biolincc.nhlbi.nih.gov/studies/accord>

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**eTable 1.** List of variables considered for inclusion in the final multivariate regression model containing predictors of good visual outcome after cataract surgery.

<b>Variables</b>
Age at cataract surgery
Sex
Race
Highest education level
Intensive glycemia therapy
Fenofibrate therapy
Intensive antihypertensive therapy
Clinical center network
Smoking status
Insurance status
Body-mass index
Cardiovascular disease
Diabetes duration
HbA1C
LDL cholesterol
HDL cholesterol
Triglycerides
Systolic blood pressure
Diastolic blood pressure
Oral hypoglycemic agents
Insulin
Aspirin
Cardiovascular agents
Lipid lowering agents
Nonsteroidal anti-inflammatory drugs
Bilateral cataract surgery
Photocoagulation/vitreotomy
Other eye surgery
Pre-operative visual acuity
Time of cataract surgery (days from randomization)



**eTable 2.** Baseline sociodemographic and clinical characteristics of participants with at least one eye excluded from the study sample.

<b>Characteristic</b>	<b>Overall (n = 474)</b>
Age at randomization, mean yrs $\pm$ SD	66.2 $\pm$ 6.5
Male sex, n (%)	277 (58.4)
Race, n (%)	
White	306 (64.6)
Black	88 (18.6)
Hispanic	26 (5.5)
Other	54 (11.4)
Highest level of education, n (%)	
Some high school	89 (18.8)
High school graduate	128 (27.0)
Some college	151 (31.9)
College graduate or more	105 (22.2)
Clinical center network, n (%)	
Canada	82 (17.3)
Western	58 (12.2)
Minnesota/Iowa	64 (13.5)
Ohio/Michigan	67 (14.1)
Northeastern	57 (12.0)
Southeastern	77 (16.2)
Veterans Affairs	69 (14.6)
Insurance coverage, n (%)	443 (93.5)
Smoking status, n (%)	
Current	37 (7.8)
Former	246 (51.9)
Never	191 (40.3)
Cardiovascular disease, n (%)	193 (40.7)
HbA1C, mean % $\pm$ SD	8.4 $\pm$ 1.0
Diabetes duration, mean yrs $\pm$ SD	13.5 $\pm$ 8.3
Medications, n (%)	
Oral hypoglycemic agents	380 (80.2)
Insulin	205 (43.2)
Aspirin	246 (51.9)
Cardiovascular agents	59 (12.4)
Lipid lowering agents	321 (67.7)
Bilateral cataract surgery	302 (63.7)

SD = standard deviation.

**eTable 3.** Baseline ocular characteristics of eyes excluded from the study sample.

<b>Characteristic</b>	<b>Overall (n = 680)</b>
Photocoagulation/vitrectomy, n (%)	89 (13.1)
Other eye surgery, n (%)	29 (4.3)
Pre-operative VA, n (%)	
<20/200	29 (7.2)
<20/40-20/200	318 (46.8)
<20/20-20/40	285 (41.9)
≥20/20	28 (4.1)

VA = visual acuity.

**eTable 4.** Distribution of ocular variables in eyes with and without good visual outcome (n=1136).

Characteristic	Good Visual Outcome	
	Yes (n = 762)	No (n= 374)
Photocoagulation/vitreotomy, n (%)	71 (9.3)	90 (24.1)
Other eye surgery, n (%)	32 (4.2)	25 (6.7)
Pre-operative VA, n (%)		
<20/200	44 (5.8)	62 (16.6)
<20/40-20/200	292 (38.3)	213 (57.0)
<20/20-20/40	388 (50.9)	95 (25.4)
≥20/20	38 (5.0)	4 (1.1)

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LDL cholesterol
HDL cholesterol
Triglycerides
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Diastolic blood pressure
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Insulin
Aspirin
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