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Visual Outcomes After Cataract Surgery In Patients With Type 2 Diabetes

Liyan Liu, MSc¹, Lisa J. Herrinton, PhD¹, Stacey Alexeeff, PhD¹, Andrew J. Karter, PhD¹, Laura B. Amsden, MSW, MPH¹, James Carolan, MD², and Neal H. Shorstein, MD³

¹Division of Research, Kaiser Permanente Northern California, Oakland, California;

²Department of Ophthalmology, Kaiser Permanente San Rafael, California

³Departments of Ophthalmology and Quality, Kaiser Permanente, Walnut Creek, California.

Abstract

Purpose: We assessed the relationships of diabetic retinopathy (DR) severity, duration of diabetes, insulin dependence, and preoperative hemoglobin (Hb) A1c with visual outcome following phacoemulsification for cataract in patients with type 2 diabetes.

Setting: Kaiser Permanente Northern California.

Design: Retrospective cohort study.

Methods: Information was obtained from the electronic medical record for patients, June 1, 2010, through May 31, 2015. We controlled for confounding factors and clustering of eyes within patients using linear mixed effects regression models for continuous outcomes and general estimating equations for dichotomous outcomes.

Results: The study included 65,370 members of whom 28% had type 2 diabetes without DR, 5% nonproliferative DR (NPDR), and 1.2% proliferative DR (PDR). Patients with diabetes and no DR were as likely as those without diabetes to achieve BCVA of 20/20 (OR 1.01, CI 0.94–1.10). The odds of 20/25 or worse postoperative vision increased with severity of retinopathy duration of diabetes, and insulin dependence, but not preoperative HbA1c. Although the odds of postoperative 20/20 was lower in patients with DR, every DR group averaged four lines of best-corrected visual acuity (BCVA) improvement, the same as patients without diabetes. Longer duration of diabetes, insulin dependence, and elevated HbA1c were not associated with worse postoperative outcomes.

Conclusion: Patients with DR and cataracts were less likely to achieve 20/20 vision but gained as many lines of vision from phacoemulsification as patients without diabetes. We see no evidence that cataract surgery should be delayed among diabetes patients with elevated HbA1c.

Corresponding Author: Lisa J. Herrinton, PhD, Division of Research, Kaiser Permanente, 2000 Broadway Avenue, Oakland, CA 94612.

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Keywords

Type 2 Diabetes; Cataract Surgery; Electronic Health Record; Visual Outcomes

INTRODUCTION

For patients with diabetes mellitus, the question of preoperative glycemic control has been a longstanding concern for surgeons, including ophthalmologists.¹ A 2012 Cochrane Collaboration report did not find a difference in surgical outcomes in relation to tight glycemic control but did find increased risk of hypoglycemic episodes and therefore recommended against tight control.² However, the Cochrane report included a wide variety of surgeries, leaving ophthalmologists uncertain.

To address this gap, we assessed whether the presence of type 2 diabetes mellitus with and without diabetic retinopathy (DR) modified the level of improvement of best-corrected visual acuity (BCVA) following phacoemulsification for cataract, where improvement was defined as change in logMAR (logMAR, postoperative minus preoperative). We hypothesized that improvement did not differ by the patient's pre-existing diabetes, severity of DR, duration of diabetes, insulin dependence, or preoperative hemoglobin (Hb) A1c level. We also assessed the odds of achieving 20/20 vision in relation to these diabetes characteristics.

METHODS

Setting

Kaiser Permanente Northern California is a fully integrated healthcare delivery system that owns its hospitals and medical offices. For most patients, care is capitated, and members receive comprehensive services. During the period of the present study, patients with diabetes were automatically enrolled into a chronic condition management registry and received regular screenings including HbA1c tests, eye examinations, and outreach by care managers. With respect to cataract surgery, the health plan's ophthalmologists perform clear cornea phacoemulsification using standardized phacoemulsification machines (Alcon, Irvine) and intraocular lenses (Alcon, Irvine).

Study Population

The study included Kaiser Permanente health plan members, aged ≥ 89 years, who underwent their first non-complex phacoemulsification for cataract (CPT codes 66984; ICD-9 codes 13.41, 13.71) during June 1, 2010 through May 31, 2015. To characterize each patient's status with respect to diabetes and other study variables, we required at least 1 year of enrollment before cataract surgery on the first eye. We excluded patients with Type 1 diabetes mellitus (ICD-9 250 with 5th digit 1 or 3 recorded at any time since 1996). As with past studies,^{3, 4} we excluded complex phacoemulsification cases and cases performed by oculoplastic or retinal specialists as well as procedures by any surgeon combined with corneal transplant (ICD-9 11.6, CPT4 codes 65710–65715) or glaucoma surgery (ICD-9 12.54, 12.64, 12.66, 12.69, 12.7, CPT4 codes 65850, 66170, 66172, 66180, 66185). For the

present analyses, we also excluded cases with previous endophthalmitis (ICD9 codes 360.00, 360.01, 360.03, 360.13, 360.19, 098.42).

The present study of more than 100,000 patients was designed to use structured data from the electronic health record with validation as needed, but without interactive review of each patient's chart. However, during the course of the study, we determined that for patients with preoperative macular edema, structured data alone was not adequate, and interactive chart review would be necessary to confirm the macular edema diagnosis and its laterality. At this point, we decided to exclude the 2% of patients with preoperative macular edema from this report and to analyze them in a smaller study in which interactive chart review would be feasible. These patients will be described in a separate report.

Data Collection

Characteristics of diabetes were obtained from the Kaiser Permanente Northern California Diabetes Registry, summarized in the Supplemental Material.^a We classified the duration of diabetes, relative to the date of cataract surgery, into three groups (<10 years, 10 years, and unknown). To do this, it was necessary to establish the diabetes incidence date, and for this, we required three years of enrollment in the health plan before the first utilization related to diabetes (i.e., the notification date as defined in the Supplemental Material). To avoid misclassifying newly joining health plan members with preexisting diabetes as having new onset diabetes, we considered those with less than three years enrollment as having unknown duration. We also captured dispensing of diabetes medications (oral, insulin) in the year before surgery and HbA1c measurements recorded within the 90 days before cataract surgery.

We assigned a single variable with hierarchical coding to classify patients into groups defined by diabetes and retinopathy. We first identified patients with at least one diagnosis code for proliferative diabetic retinopathy (PDR) (ICD-9, 362.02), then severe non-proliferative diabetic retinopathy (NPDR) (362.06), then moderate NPDR (362.05), then mild NPDR (362.04), and finally NPDR, not otherwise specified (NOS) (362.01, 362.03, and 362.0 without a fifth digit). Remaining patients were classified as having diabetes with no DR or as having no diabetes. Again, we excluded patients with a history of macular edema.

Preoperative and postoperative BCVA were obtained using Snellen charts projected by standardized equipment (Nikon, Tokyo). We did not include BCVA measurements from automated refractions, cycloplegic refractions, refractions obtained over contact lenses or glasses, retinoscopy, or "unaided acuity" because these represented <2% of the measurements and would have complicated the analysis. We obtained preoperative BCVA from measurements recorded nearest the surgery date, up to 1 year before surgery. In our system, patients who have undergone cataract surgery do not return for a postoperative refraction at a fixed time, but in relation to several factors, including the outcome of their index surgery, the need to travel to the medical campus to be seen for other ocular and systemic comorbidities, and the timing of a planned contralateral surgery, among others. Therefore, it was necessary to specify a range over which we obtained postoperative BCVA measurements. We obtained one postoperative BCVA measurement for each patient, using

that which was recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery. The minimum of 3 weeks was selected to optimize the completeness of postoperative data while providing time for vision to stabilize after surgery. The maximum of 1 year was selected to capture patients with good postoperative visual acuity who did not schedule an appointment for refraction for some time. We coded postoperative BCVA in two ways. First, we converted Snellen to logMAR equivalents using $\log\text{MAR} = -\log_{10}(20/\text{xx})$, with confirmation using a look-up table, and then treated logMAR (postoperative minus preoperative) as a continuous variable.⁵ Second, we dichotomized postoperative BCVA into two groups: 20/25 or worse and 20/20 or better.

Demographic factors, systemic comorbidities, and ocular comorbidities, procedures, and medications were obtained from membership, inpatient, and outpatient data recorded during the year before surgery. Pre-existing ocular procedures included vitreoretinal procedures (14.x). Preexisting ocular diseases included age-related macular degeneration (362.5), glaucoma (365 except 365.52), other corneal disorders (371), and epiretinal membrane (362.56). Glaucoma medications included prostaglandin analogs, alpha agonists, and carbonic anhydrase inhibitors dispensed during the year before surgery. Because exposure of oral alpha-1 agonists has been associated with floppy iris syndrome, we obtained tamsulosin records for up to 10 years before surgery. Anti-VEGF was also obtained from pharmacy records. Prophylaxis for macular edema was coded as topical prednisolone alone, prednisolone with NSAID, and other, which included depot and other intraoperative administrations as well as non-compliance with topical medication as reflected by lack of a pharmacy dispensing.

Charlson comorbidities were obtained from diagnostic and procedure codes recorded during the year before surgery.⁶ For this study of diabetes patients, we computed the modified Charlson comorbidity index without assigning points for diabetes, kidney disease, or diabetes with end organ damage. Hypertension was defined using ICD-9 diagnosis codes (401–405) and use of antihypertensive medications. Chronic pulmonary disease (490–496.99, 500–505, 506.4), and kidney disease (582.xx, 583–583.7, 585–586.99, 588.xx) were defined using ICD-9 codes. Cardiovascular disease included myocardial infarction (410.xx, 412), congestive heart disease (428.xx), and stroke (430–438.99).

Data Analysis

We estimated the average logMAR and its 95% confidence interval (CI) by fitting a linear mixed effects model.^b We used random intercepts for individual patients, surgeons, and hospitals to account for clustering of eyes within patients, clustering of patients within surgeons, and clustering of surgeons within hospitals. To model the dichotomous outcome of postoperative BCVA better than 20/25 vs 20/20 or worse, we fit a generalized-estimating-equations model with a logit-link function.^c This semi-parametric model accounted for clustering of eyes within patients and was robust to the choice of the working covariance structure. We estimated the odds ratio (OR) and 95% CI for the association of postoperative BCVA 20/25 or worse vs 20/20 with diabetes characteristics. The models were adjusted for patient-level variables to control for potential confounding by patient factors. We evaluated each potential patient-level confounder by comparing regression coefficients for the diabetes

variables and overall model fit between models that included and excluded the potential variable. Some variables that did not operate as confounders were retained in the models because of their clinical importance. We performed subgroup analyses based on the patient's race, because the manifestations of diabetes may differ by race, and in relation to past diagnoses of age-related macular edema and epiretinal membrane. All analyses were performed using SAS 9.3.

Institutional Review Board (IRB)/Ethics Committee approval was obtained.

RESULTS

Before exclusions, we identified 135,095 eyes in 87,010 patients aged 20–89 years that underwent cataract surgery during June 1, 2010, to May 31, 2015 (Figure 1). After exclusions, the number remaining eligible was 127,008 eyes (94%) in 81,785 patients (94%). Among these, information on postoperative BCVA was available for 102,050 eyes (80%) in 65,370 patients (79%).

Of the 65,370 patients included in the study, 34% (N=22,360) had diabetes. Characteristics of their diabetes are provided in Table 1 in relation to postoperative BCVA 20/20. Because of the large sample size, even small differences were statistically significant. Of the 22,360 patients with diabetes, 81% had diabetes without DR, 15% had diabetes with NPDR, and 4% had diabetes with PDR. Duration of diabetes was <10 years in 47% of patients, 10 years in 41%, and unknown in 12%. Insulin was used by 20% of patients. In 41%, HbA1c had been measured in the 90 days before surgery. Baseline diabetes characteristics of patients with information missing on their postoperative BCVA are provided in Supplemental Table 1. Of patients with diabetes, those with missing postoperative BCVA were slightly more likely to have retinopathy (1320 [24%] versus 4184 [19%]), to use insulin (1355 [25%] versus 4568 [20%]), and to have HbA1c of 9.0% or higher (359 [7%] versus 935 [4%]).

Focusing on the first surgical eye, among those without diabetes, the average preoperative BCVA was 20/68 and average postoperative BCVA was 20/25 (Table 2). In those with diabetes but no retinopathy, pre- and postoperative BCVA were only slightly worse (20/71 and 20/26, respectively). Among those with mild or moderate NPDR, average postoperative BCVA declined only slightly with severity. Patients with severe NPDR or PDR averaged 20/30 and 20/34 postoperatively. The distribution of preoperative BCVA was bimodal for patients with and without diabetes, with maxima at 20/50 and 20/150 (Supplemental Figure 1). Similar to the distribution of preoperative BCVA, the distribution of logMAR (postoperative minus preoperative) was bimodal with peaks occurring at −0.4 (corresponding to about four lines on the Snellen chart) and −0.9 (Figure 2). The average logMAR was −0.43 in patients without diabetes and nearly identical in most DR groups, but it was slightly better, −0.50, in patients with severe NPDR (Table 2).

Patient characteristics other than diabetes characteristics are provided in Table 3. In this bivariate analysis that did not use statistical adjustment, the following characteristics were most strongly associated with worse postoperative BCVA: older age, body mass index 18.5 kg/m², specific ocular comorbidities, and worse preoperative vision. Among all patients

(Supplemental Table 2), those with missing postoperative BCVA were slightly more likely to have had surgery during the earlier years of the study, to be young and male, to have worse preoperative BCVA, and to have received unilateral surgery. In addition, diabetes patients were slightly more likely to have received NSAID as prophylaxis for macular edema.

Table 4 provides the results of the random effects mixed model of logMAR (postoperative minus preoperative). The first column of numbers provides the unadjusted average

logMAR for each of the reference groups, while the second column provides the additional increase or decrease in logMAR compared to the reference group, after adjustment. Recall that negative values of logMAR reflect greater improvement, while positive values reflect lesser improvement. For example, in patients without diabetes, logMAR averaged -0.43 (improved), while in patients with diabetes without DR, the additional logMAR averaged -0.02 (95% CI -0.03 to -0.01), i.e., -0.45 logMAR. The adjusted analysis included up to two eyes per patient and accounted for clustering of eyes within patient, patient within surgeon ($N=158$), and surgeon within facility ($N=17$). After adjustment, the correlation in logMAR between the average patient's two eyes was 0.23 (not shown). For nearly every characteristic listed in Table 4, including every diabetes characteristic, the additional increase or decrease in logMAR related to the characteristic was slight. The only characteristic that was related to at least ± 0.1 logMAR (representing about one line) was history of vitreoretinal procedure (change, -0.14 logMAR with 95% CI -0.17 to -0.12).

Table 5 provides the multivariable-adjusted OR and 95% CI for associations with postoperative BCVA 20/25 or worse compared with 20/20. The analysis included up to two eyes per patient and accounted for clustering of eyes within patient. After adjustment, the correlation between the average patient's two eyes in postoperative BCVA, as dichotomized, was 0.54 (not shown). Eyes of patients with diabetes but not DR had nearly the same odds of 20/25 or worse as eyes of patients without diabetes (OR 1.01 , CI 0.94 – 1.10). In contrast, eyes of patients with a diagnosis of retinopathy had increased odds of postop BCVA 20/25 or worse, with increasing DR severity associated with increasing odds of BCVA 20/25 or worse (PDR vs no diabetes: OR 3.56 , CI 2.93 – 4.33). The adjusted OR was also slightly elevated in eyes of patients with duration of diabetes ≥ 10 years (vs. <10 years, OR 1.14 , CI 1.07 – 1.22) and with insulin dependence (vs. no medication, OR 1.12 , CI 1.03 – 1.22). However, oral diabetes medication without insulin (OR 1.02 , CI 0.96 – 1.09) and HbA1c level $\geq 9.0\%$ (OR 0.99 , CI 1.14) were not related to the odds of postoperative BCVA 20/25 or worse. Preoperative BCVA ($\geq 20/100$ compared with $\geq 20/40$) was modestly associated with postoperative BCVA 20/25 or worse (OR 1.59 , CI 1.54 – 1.65). The following patient characteristics were associated with $\geq 10\%$ increased odds of postoperative BCVA 20/25 or worse: older age, female sex, non-white race/ethnicity, and body mass index ≥ 35 kg/m²; a history of hypertension, cardiovascular disease, age-related macular degeneration, corneal disease, epiretinal membrane, vitreoretinal procedure, anti-VEGF medication, and a diagnosis of glaucoma or use of a glaucoma medication. Compared to prophylaxis for macular edema using topical prednisolone alone, prophylaxis using NSAID (OR 0.81 , CI 0.79 – 0.84) or other prophylaxis (OR 0.75 , CI 0.70 – 0.81) was associated with reduced odds of postoperative BCVA 20/25 or worse in these patients without a history of macular edema.

Subgroup analyses are provided in Supplemental Tables 3 and 4 for race/ethnicity, age-related macular edema, and epiretinal membrane. African-American patients and those with epiretinal membrane may have had slightly greater visual acuity improvements than others following phacoemulsification.

DISCUSSION

We evaluated visual outcome following cataract surgery in a large, community-based cohort of patients with and without diabetes and with no prior history of macular edema. In this ethnically diverse (36% nonwhite) population undergoing phacoemulsification for cataract, the prevalence of diabetes was 34%, including 28% without retinopathy, 5% with NPDR, and 1% with PDR, slightly higher than the prevalence of 22% reported for the cataract surgery population of Rochester, Minnesota (3% nonwhite).^{7,d} Among diabetes patients, 81% had diabetes without retinopathy and another 8–13% had mild retinopathy. We evaluated improvement in BCVA (postoperative minus preoperative logMAR), observing an average four lines of BCVA improvement in every patient group we studied as defined by degree of retinopathy, duration of diabetes, insulin dependence, and HbA1c level. Consistent with previous reports, differences in improvement by severity of DR, duration of diagnosis, and insulin dependence were unmeasurable or slight.^{8,9} Eyes of patients with HbA1c ≥9% had half a line *greater* improvement than eyes of patients with preoperative HbA1c <6.5%. We also evaluated the odds of achieving 20/20 vision. Consistent with previous reports, patients with diabetes but no DR had the same odds of achieving 20/20 vision as patients without diabetes, and in eyes with DR, increasing severity of retinopathy was associated with decreased odds of postoperative 20/20 vision.^{10,11}

In older adults with type 2 diabetes, attempting to lower HbA1c levels over the short-term in preparation for surgery could harm rather than benefit patients by increasing the risk of hypoglycemic episodes.² Although a higher level of HbA1c has been reported to increase the progression of retinopathy over the long-term¹², the current study did not find a difference in attaining 20/20 vision, while the postoperative improvement in BCVA was increased. Therefore, it appears to be unnecessary for surgeons to delay cataract surgery to reduce the HbA1c level.

We found a greater-than-expected improvement in postoperative BCVA in patients with and without diabetes who had a prior vitreoretinal procedure. Eyes with prior vitrectomy are known to have more opaque nuclear sclerosis than is seen with age-related cataract alone. This has been surmised to increase the risk of complications of cataract surgery and thereby reduce the benefit in terms of visual outcome.¹³ However, contemporary phacoemulsification results in relatively few complications. We found that patients with a history of vitreoretinal procedure have worse BCVA preoperatively and greater opportunity for improvement. Not surprisingly, patients with age-related macular degeneration, glaucoma, and epiretinal membrane had lower odds of achieving postoperative BCVA of 20/20 or better, likely because poor macular or optic nerve function limited their visual potential. We recommend surgeons set realistic expectations for postoperative BCVA with patients with moderate to severe NPDR and PDR and for patients with clinically significant glaucoma, age-related macular degeneration and epiretinal membrane.

We observed increased odds of achieving 20/20 vision in patients using prophylactic NSAIDs compared with prednisolone alone. This finding may or may not suggest a long-term benefit from prophylactic NSAID instillation. We measured postoperative BCVA for this study between 3 weeks and 1 year from the date of surgery. It has been suggested that BCVA in the early postoperative period (<3 months) may benefit from NSAID while there is little evidence that long term vision (> 3 months) realizes a benefit.¹⁴ The risk of macular edema following cataract surgery reportedly increases with duration of diabetes, severity of DR, and increased HbA1c.^{11, 15} It has been posited that cataracts can mask low-grade macular edema, so that cataract surgery increases detection of, but not risk of, macular edema.^{9, 16} We plan a separate report of macular edema focusing on the timing of postoperative refraction visits, association of macular edema, severity of retinopathy and postoperative BCVA.

Strengths of this study include the large, well-defined, community-based cohort; excellent postoperative follow-up of patients with CDVA measurements; detailed information on potential confounding factors; and generalizability to other community-based settings. A key concern with observational studies is the potential for unmeasured confounding, in which, for example, patients with diabetes are systematically different from those without diabetes in ways that are not recorded and cannot be adjusted. Our ability to access and adjust for a wide range of covariables reduced the potential for confounding. Another potential limitation was the large number of patients with information missing on postoperative BCVA. To address this, we analyzed differences in baseline characteristics among patients with and without postoperative BCVA, finding only slight differences in baseline characteristics. Finally, this analysis excluded 2% of patients with a past diagnosis of macular edema, because the study schedule did not permit detailed chart review to confirm these diagnoses and determine laterality. Although this decision increased the validity of the study, it may have reduced generalizability somewhat.

In conclusion, we found that patients with DR are less likely to achieve 20/20 and we saw a trend of worse postoperative BCVA with severity of retinopathy. Nevertheless, every patient group we studied, including those without diabetes and those with the most severe DR, had a geometric average of four lines of improvement in visual acuity. We see no reason to delay cataract surgery based on HbA1c levels. Timely cataract surgery benefits the diabetes patient by extending their visual function and overall well-being.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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LITERATURE CITED

1. Peterson SR, Silva PA, Murtha TJ, Sun JK. Cataract surgery in patients with diabetes: Management strategies. *Semin Ophthalmol*. 2018; 33:75–82. [PubMed: 29144826]
2. Buchleitner AM, Martínez-Alonso M, Hernández M, Solà I, Mauricio D. Perioperative glycaemic control for diabetic patients undergoing surgery. *Cochrane Database Syst Rev*. 2012 9 12; CD007315. [PubMed: 22972106]
3. Shorstein NH, Liu L, Waxman MD, Herrinton LJ. Comparative effectiveness of three prophylactic strategies to prevent clinical macular edema after phacoemulsification surgery. *Ophthalmology*. 2015 12; 122:2450–6. [PubMed: 26409728]
4. Herrinton LJ, Shorstein NH, Paschal JF, Liu L, Contreras R, Winthrop KL, Chang WJ, Melles RB, Fong DS. Comparative effectiveness of antibiotic prophylaxis in cataract surgery. *Ophthalmology*. 2016 2; 123:287–94. [PubMed: 26459998]
5. Holladay JT. Proper method for calculating average visual acuity. *J Refract Survey*. 1997; 13:388–91.
6. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol*. 1992; 45:613–19. [PubMed: 1607900]
7. Erie JC, Pueringer MR, Brue SM, Chamberlain AM, Hodge DO. Statin use and incident cataract surgery: A case-control study. *Ophthalmic Epidemiol*. 2016; 23:40–5. [PubMed: 26766069]
8. Eriksson U, Alm A, Bjärnhall G, Granstam E, Matsson AW. Macular edema and visual outcome following cataract surgery in patients with diabetic retinopathy and controls. *Graefes Arch Clin Exp Ophthalmol*. 2011; 249:349–59. [PubMed: 20827486]
9. Ostri C, Lund-Andersen H, Sander B, La Cour M. Phacoemulsification cataract surgery in a large cohort of diabetes patients: visual acuity outcomes and prognostic factors. *J Cataract Refract Surg*. 2011; 37:2006–12. [PubMed: 21889874]
10. Stunf Pukl S, Vidovi Valentin i N, Urban i M, Irman Gr ar I, Gr ar R, Pfeifer V, Globo nik Petrovi M. Visual acuity, retinal sensitivity, and macular thickness changes in diabetic patients without diabetic retinopathy after cataract surgery. *J Diabetes Res*. 2017; 3459156. [PubMed: 28243608]
11. Yang J, Cai L, Sun Z, Ye H, Fan Q, Zhang K, Lu W, Lu Y. Risk factors for and diagnosis of pseudophakic cystoid macular edema after cataract surgery in diabetic patients. *J Cataract Refract Surg*. 2017; 43:207–214. [PubMed: 28366368]
12. Scanlon PH, Aldington SJ, Stratton IM. Epidemiological issues in diabetic retinopathy. *Middle East Afr J Ophthalmol* 2013 Oct-Dec; 20:293–300. [PubMed: 24339678]
13. Do DV, Gichuhi S, Vedula SS, Hawkins BS. Surgery for post-vitrectomy cataract. *Cochrane Database Syst Rev*. 2013 Dec 19; CD006366. Update in: *Cochrane Database Syst Rev* 2018 1 10; 1:CD006366.
14. Kim SJ, Schoenberger SD, Thorne JE, Ehlers JP, Yeh S, Bakri SJ. Topical nonsteroidal anti-inflammatory drugs and cataract surgery: a report by the American Academy of Ophthalmology. *Ophthalmology*. 2015; 122:2159–2168. [PubMed: 26123091]
15. Denniston AK, Chakravarthy U, Zhu H, Lee AY, Crabb DP, Tufail A, Bailey C, Akerele T, Al-Husainy S, Brand C, Downey L, Fitt A, Khan R, Kumar V, Lobo A, Mahmood S, Mandal K, McKibbin M, Menon G, Natha S, Ong JM, Tsaloumas MD, Varma A, Wilkinson E, Johnston RL, Egan CA; for the UK DR EMR Users Group. The UK Diabetic Retinopathy Electronic Medical Record (UK DR EMR) Users Group, Report 2: Real-world data for the impact of cataract surgery on diabetic macular oedema. *Br J Ophthalmol*. 2017; 101:1673–1678. [PubMed: 28487377]
16. Ostri C. Intraocular surgery in a large diabetes patient population: risk factors and surgical results. *Acta Ophthalmol*. 2014 5; 92 Thesis1:1–13.

Other Cited Material

- a. Diabetes Study of Northern California. Kaiser Permanente Division of Research. <https://www.dor.kaiser.org/external/DORExternal/research/distance.aspx>. Accessed May 12, 2017.

- b. SAS. Overview: MIXED procedure. SAS/STAT(R) 9.22 User's Guide. https://support.sas.com/documentation/cdl/en/statug/63347/HTML/default/viewer.htm#statug_mixed_sect001.htm. Accessed March 9, 2018.
- c. SAS. Overview: The GENMOD procedure. SAS/STAT(R) 9.22 User's Guide. http://documentation.sas.com/?docsetId=statug&docsetTarget=statug_genmod_overview.htm&docsetVersion=14.3&locale=en. Accessed March 9, 2018.
- d. Statistical Atlas, Demographics. Race and ethnicity in Rochester, Minnesota. <https://statisticalatlas.com/place/Minnesota/Rochester/Race-and-Ethnicity>. Accessed March 9, 2018.

What Was Known

- Research has found no difference in surgical outcomes in relation to tight preoperative glycemic control but increased risk of hypoglycemic episodes. However, these studies included a wide variety of surgeries, without a close focus on cataract surgery, leaving ophthalmologists uncertain.

What This Paper Adds

- Patients do not need to wait for HbA1c control before undergoing cataract surgery.
- Patients with diabetic retinopathy gain as many lines of improvement in vision as patients without retinopathy or diabetes.

Synopsis

We investigated how diabetes-related eye disease modified visual outcomes following cataract phacoemulsification. Patients with diabetic retinopathy gained as many lines of vision as patients without retinopathy or diabetes.

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Figure 1.

Study inclusion and exclusion, Kaiser Permanente Northern California members who underwent cataract surgery during June 2010 to May 2015

Figure 2.

logMAR* in relation to diabetes and diabetic retinopathy (postoperative minus preoperative), first eye only, 65,370 members of Kaiser Permanente Northern California who underwent cataract surgery during June 2010 to May 2015.

logMAR of ± 0.1 units represents about 1 line of change on the Snellen chart (e.g. 20/200 to 20/160, or 20/25 to 20/20). Negative values of logMAR reflect greater improvement, while positive values reflect lesser improvement.

Table 1.

Diabetes characteristics of patients who underwent cataract surgery, and % with postoperative BCVA 20/20 or better, first eye only, 22,360 diabetes patients, Kaiser Permanente Northern California, June 1, 2010 to May 31, 2015.

Characteristic	N	Prevalence among diabetes patients, %	% of patients with Postoperative BCVA 20/20 or better [*]
Diabetes group			
Diabetes without DR	18,176	81	45
NPDR NOS	1,097	5	40
Mild NPDR	1,751	8	40
Moderate NPDR	502	2	33
Severe NPDR	43	0.2	30
PDR	791	4	20
Duration of diabetes, years			
<10	8,196	37	46
10	9,196	41	39
Unknown	4,968	22	46
Diabetes treatment ^a			
None	9,214	41	48
Oral without insulin	8,578	38	44
Insulin +/- oral medication	4,568	20	40
Preoperative HbA1c, % ^b			
9.0	935	4	44
6.5–8.9	5,512	25	42
<6.5	2,812	13	44
Not measured	13,101	59	43

BCVA was obtained from manifest refraction using Snellen charts projected by standardized equipment (Nikon, Tokyo). Postoperative BCVA was obtained from the earliest measurement recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery.

^aUse of diabetes medications (oral, insulin) in the year before surgery.

^bHbA1c measurements recorded within the 90 days before cataract surgery.

^{*} All p-values <0.001 except for severe NPDR (p=0.04) and NPDR NOS (p=0.001) relative to diabetes without DR; and HbA1c 9.0% relative to <6.5% (p <0.01).

Abbreviations: DR = diabetic retinopathy. NPDR = nonproliferative diabetic retinopathy. PDR = proliferative diabetic retinopathy. NOS = not otherwise specified. HbA1c = Hemoglobin A1c.

Preoperative and postoperative BCVA in relation to diabetes and diabetic retinopathy (DR), first eye only, 65,370 members of Kaiser Permanente Northern California, 2010–2015.

Table 2.

Group	Preoperative				Postoperative				Change
	logMAR		Snellen	Geometric mean ^a	logMAR		Snellen	logMAR	
	Average	Std dev	Average		Std dev				
No diabetes	0.53	0.29	20/68		0.10	0.15	20/25	-0.43	
Diabetes without DR	0.55	0.29	20/71		0.11	0.15	20/26	-0.44	
NPDR, NOS	0.57	0.30	20/74		0.13	0.17	20/27	-0.44	
Mild NPDR	0.58	0.29	20/76		0.13	0.17	20/27	-0.45	
Moderate NPDR	0.59	0.31	20/77		0.15	0.19	20/28	-0.44	
Severe NPDR	0.68	0.34	20/96		0.18	0.25	20/30	-0.50	
PDR	0.67	0.33	20/93		0.23	0.23	20/34	-0.44	

^aComputed by converting the average logMAR to Snellen using a look-up table as explained by Holladay.⁶

Baseline characteristics of patients who underwent cataract surgery, and % with postoperative BCVA 20/20 or better, first eye only, 65,370 members of Kaiser Permanente Northern California, June 1, 2010 to May 31, 2015.

Table 3.

Characteristic	Prevalence in the study population, %	% of patients in the stratum with postoperative BCVA 20/25 or worse*		
		No diabetes (N=43,010)	Diabetes without DR (N=18,176)	Diabetes with DR (N=4,184)
Overall	100%	51	55	65
Year of surgery	2010–11	53	56	66
	2012–13	50	55	64
	2014–15	51	55	64
Patient age, years	69	37	40	56
	70–79	52	57	69
	80–89	69	72	76
Patient sex	Male	49	54	63
	Female	52	57	67
Patient race/ethnicity	White	50	53	64
	African-American	52	56	65
	Asian-American	56	57	67
	Hispanic	54	58	66
	Other	53	59	61
Body mass index, Kg/m ²	18.4	61	71	71
	18.5–24.9	54	62	70
	25–29.9	50	56	64
	>30	48	51	63
	Missing	48	54	75
Smoking history	Ever	51	55	65
	Never	51	55	65
	Unknown	55	60	68
	0	48	51	57
Charlson Comorbidity	1	54	56	64
	2	58	61	70

Characteristic	Prevalence in the study population, %	% of patients in the stratum with postoperative BCVA 20/25 or worse*		
		No diabetes (N=43,010)	Diabetes without DR (N=18,176)	Diabetes with DR (N=4,184)
Hypertension	Yes	54	56	65
Cardiovascular disease	Yes	60	62	70
Chronic pulmonary disease	Yes	54	57	65
Kidney disease	Yes	59	61	70
Ocular comorbidity	AMD	61	74	78
	Glaucoma	56	60	71
	Other corneal disease	68	74	77
	Epiretinal membrane	66	70	79
	Vitreoretinal px	79	83	91
	Anti-VEGF medication	89	89	85
	Glaucoma medication	63	66	77
	Tamulosin	55	58	63
Macular edema prophylaxis	Topical prednisolone	53	58	69
	NSAID +/- pred	49	53	62
	Other	57	58	75
Preoperative BCVA	20/40 or better	42	46	54
	20/50 to 20/60	52	57	65
	20/70 to 20/80	56	60	69
	20/100 or worse	56	59	70
Surgery timing	2 eyes within 2 months	49	53	62
	2 eyes within 1 year	53	59	63
	1 eye within 1 year	52	56	68

Abbreviations: DR = diabetic retinopathy. AMD = age-related macular degeneration. VEGF = vascular endothelial growth factor. NSAID = nonsteroidal anti-inflammatory drug.

Best-correct visual acuity (BCVA) was obtained from manifest refraction using Snellen charts projected by standardized equipment (Nikon, Tokyo). Postoperative BCVA was obtained from the earliest measurement recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery.

* All p-values <0.001 except for body mass index 18.4 (p <0.01), body mass index missing (p <0.01), vitreoretinal procedure (p=0.14), anti-VEGF medication (p=0.80), and tamulosin in the past 10 years (p <0.01).

logMAR, postoperative minus preoperative, by patient characteristics, after adjustment using mixed effects regression modeling, Kaiser Permanente Northern California, June 1, 2010 to May 31, 2015.

Table 4.

Characteristic	logMAR (postoperative minus preoperative)		
	Unadjusted average logMAR, 1 st eye	Adjusted* Additional logMAR compared to the reference group	95% CI
Diabetes	No diabetes	Ref	
	Diabetes without DR	-0.02	-0.03 -0.01
	Mild NPDR	-0.02	-0.04 0.00
	Moderate NPDR	0.01	-0.02 0.04
	Severe NPDR	0.01	-0.08 0.09
	NPDR NOS	-0.01	-0.03 0.01
Duration of diabetes, years	PDR	0.02	0.00 0.05
	<10	Ref	
	10	0.02	0.01 0.02
	Unknown	0.00	-0.01 0.01
Diabetes treatment	None	Ref	
	Oral without insulin	-0.01	-0.01 0.00
	Insulin	-0.01	-0.02 0.00
	9.0	-0.04	-0.07 -0.02
Preoperative HbA1c, %	6.5–8.9	0.01	0.00 0.02
	<6.5	Ref	
	Not measured	0.01	0.00 0.02
	69	Ref	
Patient age, years	70–79	0.06	0.06 0.07
	80–89	0.09	0.09 0.10
	Male	Ref	
Patient sex	Female	0.00	0.00 0.01
	White	Ref	
Patient race/ethnicity	African-American	0.00	-0.01 0.01

Characteristic	logMAR (postoperative minus preoperative)		
	Unadjusted average logMAR, 1 st eye	Adjusted* Additional logMAR compared to the reference group	95% CI
Body mass index, Kg/m ²	Asian-American	0.00	0.00 0.01
	Hispanic	-0.02	-0.03 -0.02
	other	0.00	-0.01 0.00
	18.4	-0.04	-0.06 -0.02
	18.5–24.9	Ref	
Charlson comorbidity ^c	25–29.9	0.00	0.00 0.01
	>30	0.00	-0.01 0.00
	Missing	-0.04	-0.07 -0.02
Systemic comorbidity (yes vs no)	0	Ref	
	1	0.00	-0.01 0.01
	2	-0.01	-0.02 0.00
Ocular comorbidity (yes vs no)	Hypertension	0.00	0.00 0.01
	Cardiovascular disease	-0.01	-0.01 0.00
	Chronic pulm disease	0.00	0.00 0.01
	Kidney disease	0.00	-0.01 0.00
	AMD	-0.38	0.03 0.04
Macular edema prophylaxis	Glaucoma	0.03	0.02 0.03
	Other corneal	0.05	0.04 0.06
	Epiretinal membrane	0.05	0.04 0.06
	Vitreoretinal procedure	-0.14	-0.17 -0.12
	Anti-VEGF medication	0.06	0.03 0.09
Surgical timing	Glaucoma medication	0.02	0.01 0.03
	Tamulosin ^f	0.02	0.02 0.03
	Topical prednisolone	Ref	
Surgical timing	NSAID +/- prednisolone	-0.01	-0.01 0.00
	Other	0.00	-0.01 0.01
	2 eyes within 2 months	0.09	0.08 0.09
	2 eyes within 1 year	0.03	0.02 0.04

Characteristic	logMAR (postoperative minus preoperative)		
	Unadjusted average logMAR, 1 st eye	Adjusted* Additional logMAR compared to the reference group	95% CI
1 eye within 1 year	-0.47	Ref	

Abbreviations: DR = diabetic retinopathy. AMD = age-related macular degeneration. VEGF = vascular endothelial growth factor. NSAID = nonsteroidal anti-inflammatory drug.

Best-correct visual acuity (BCVA) was obtained from manifest refraction using Snellen charts projected by standardized equipment (Nikon, Tokyo). Postoperative BCVA was obtained from the earliest measurement recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery.

* The single regression analysis included every variable shown in this table and was stratified on the identity of the patient, surgeon, and facility. Best-corrected visual acuity (BCVA) was obtained from manifest refraction using Snellen charts projected by standardized equipment (Nikon, Tokyo). Postoperative BCVA was obtained from the earliest measurement recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery. Negative values reflect greater improvement and positive values reflect lesser improvement as compared with the reference group. We also assessed year of surgery, smoking history, and time to postoperative measurement of BCVA, but these variables did not confound the associations.

Table 5.

Adjusted odds ratio (OR) and 95% confidence interval (95% CI) for the association of diabetes and diabetes characteristics with postoperative BCVA 20/25 or worse compared with 20/20 or better, Kaiser Permanente Northern California, June 1, 2010 to May 31, 2015. The analysis included 102,050 eyes in 65,370 patients.

Characteristic	20/25 or worse compared with 20/20 or better		
	Adjusted OR	95% CI	
Diabetes	Ref		
No diabetes		0.94	1.10
Diabetes without DR	1.01		
Mild NPDR	1.19	1.05	1.35
Moderate NPDR	1.89	1.55	2.29
Severe NPDR	2.43	1.24	4.75
NPDR NOS	1.27	1.10	1.46
PDR	3.56	2.93	4.33
Duration of diabetes, years	Ref		
<10		1.07	1.22
10	1.14		
Unknown	1.05	0.98	1.13
Diabetes treatment	Ref		
None		0.96	1.09
Oral without insulin	1.02		
Insulin	1.12	1.03	1.22
Preoperative HbA1c, %	0.99	0.86	1.14
9.0	1.03	0.95	1.12
6.5–8.9	Ref		
<6.5		0.95	1.10
Preoperative BCVA	1.02		
Not measured		1.30	1.38
20/40	Ref		
20/50 to 20/60	1.34	1.43	1.54
20/70 to 20/100	1.48	1.54	1.65
20/100	1.59		
Patient age, years	Ref		
69		1.79	1.92
70–79	1.85	3.28	3.59
80–89	3.43		
Patient sex	Ref		
Male			

Characteristic	20/25 or worse compared with 20/20 or better		
	Adjusted OR	95% CI	
Patient race/ethnicity	Female	1.20	1.16 1.24
	White	Ref	
	African-American	1.14	1.07 1.23
	Asian-American	1.54	1.47 1.61
	Hispanic	1.26	1.19 1.33
Body mass index, Kg/m ²	Other	1.22	1.15 1.30
	18.4	1.23	1.10 1.37
	18.5–24.9	Ref	
	25–29.9	0.94	0.90 0.97
	>30	0.92	0.88 0.96
Charlson comorbidity ^c	Missing	1.05	0.91 1.21
	0	Ref	
	1	1.04	0.99 1.09
	2	1.08	1.01 1.15
	Hypertension	1.15	1.11 1.20
Systemic comorbidity (yes vs no)	Cardiovascular disease	1.15	1.09 1.21
	Chronic pulmonary disease	0.99	0.95 1.04
	Kidney disease	1.04	0.99 1.09
	AMD	1.85	1.76 1.95
	Glaucoma	1.85	1.76 1.95
Ocular comorbidity (yes vs no)	Other corneal	1.92	1.78 2.07
	Epiretinal membrane	1.67	1.55 1.79
	Vitreoretinal procedure	2.95	2.49 3.50
	Anti-VEGF medication	2.96	2.23 3.94
	Glaucoma medication	1.41	1.33 1.50
Macular edema prophylaxis	Tamulosin	1.05	0.99 1.12
	Topical prednisolone	Ref	
	NSAID +/- prednisolone	0.81	0.79 0.84
	Other	0.75	0.70 0.81
	2 eyes within 2 months	0.92	0.89 0.95

Characteristic	20/25 or worse compared with 20/20 or better		
	Adjusted OR	95% CI	
2 eyes within 1 year	0.99	0.94	1.03
1 eye within 1 year	Ref		

Abbreviations: DR = diabetic retinopathy. AMD = age-related macular degeneration. VEGF = vascular endothelial growth factor. NSAID = nonsteroidal anti-inflammatory drug.

Best-correct visual acuity (BCVA) was obtained from manifest refraction using Snellen charts projected by standardized equipment (Nikon, Tokyo). Postoperative BCVA was obtained from the earliest measurement recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery.

Results from a generalized estimating equations model that included every variable shown in this table simultaneously and accounted for the correlation between two eyes of the same patient. BCVA was obtained from manifest refraction using Snellen charts projected by standardized equipment (Nikon, Tokyo). Postoperative best-corrected visual acuity (BCVA) was obtained from the earliest measurement recorded nearest the date of surgery during the interval 3 weeks to 1 year after surgery. We also assessed year of surgery, smoking history, and time to postoperative measurement of BCVA, but these variables did not confound the associations.