Straylight measurements as an indication for cataract surgery

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PURPOSE: To assess adding straylight measurements to the indication for cataract surgery.

SETTING: Onze Lieve Vrouwe Hospital, Amsterdam, and Zonnestraal Eye Clinic, Hilversum, The Netherlands.

DESIGN: Prospective interventional cohort study.

METHODS: Before and after cataract extraction, corrected distance visual acuity (CDVA) and straylight were recorded in all patients. Subjective complaints were documented by the 39-item National Eye Institute Visual Function Questionnaire (NEI VFQ-39) and a straylight questionnaire.

RESULTS: The population comprised 217 patients with a mean age of 72 years ± 9.12 (SD) (range 29 to 90 years). Preoperatively, the mean straylight was 1.55 ± 0.29 log(s) and the mean CDVA, 0.28 ± 0.21 logMAR. Visual acuity and straylight showed little correlation ($R^2 = 0.08$). The mean postoperative improvement in CDVA was 0.26 ± 0.20 logMAR (range −0.12 to 1.12 logMAR) and in straylight, 0.31 ± 0.32 log(s) (range −0.50 to 1.27 log[s]). The preoperative breakeven point (50% chance of postoperative improvement) was 0.06 logMAR for CDVA and 1.29 log(s) for straylight. Preoperative and postoperative questionnaires showed straylight had almost the same influence as visual acuity on quality of vision.

CONCLUSIONS: Straylight and visual acuity measure different aspects of quality of vision and influenced subjective visual quality almost equally. When straylight was added to preoperative considerations of cataract extraction, postoperative results were more predictable.

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Cataract is the leading cause of blindness worldwide,[1] and cataract surgery is the most commonly performed elective surgical procedure.[A] Because lens opacities usually develop slowly, effects on quality of vision can be variable[1]; the presence of lens opacities in and of itself does not justify cataract extraction.[2] At present, exactly when lens opacities are classified as cataract and how much visual loss or subjective symptoms must be present to justify the definition of cataract are inconsistent in different health care settings.[1] The decision whether to operate is based on a combination of subjective complaints and ocular examinations, and may vary between surgeons and regions.[2–4] Because a large amount of monetary and human resources are spent on cataract extraction,[3] there is a need for new objective tests to develop a standardized indication paradigm for cataract surgery that will increase the chances of postoperative improvement.[2]

At present, visual impairment is usually qualified as loss of visual acuity only and the indication for cataract extraction is mainly based on visual acuity.[1–7] Nevertheless, it may be difficult to accurately predict the outcomes of cataract extraction in individual patients because visual acuity is a relative value and does not represent all aspects of quality of vision.[3,5–14] Although other factors can influence the postoperative visual results, additional vision tests, such as contrast sensitivity and glare sensitivity, are infrequently used in the preoperative decision-making process.[2,3] However, previous studies[5–8,12–14] have shown that additional vision tests provide important preoperative information that correlate with patients' complaints and are valuable in assessing the quality of vision. Recent cataract surgery guidelines advise that in addition to visual acuity, one should consider other measures of visual functioning (eg, glare or halos) and the degree of

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functional disability when making recommendations for surgery and evaluating the outcomes of surgery.[15,A] The surgeon is counseled to consider cataract surgery when the visual impairment is directly attributable to the presence of lens opacities.[15]

Many cataract patients with excellent visual acuity report glare and other visual problems because cataract leads to an increased amount of straylight, which can cause disability glare.[6–11,13,14,16,17] Light scattered by the eye's imperfect optical media causes a veil of straylight over the retina, which is relative to forward light scatter.[10,11,14,16] It diminishes the contrast of the retinal image and causes symptoms of disability glare and halos.[10,11,14,16] Straylight is an objective physiologic measure of the large-angle domain of the retinal point-spread function (PSF); this is in contrast to visual acuity, which is influenced by the small-angle domain of the PSF.[5,10,11,14,16] Because quality of vision is related to both domains of the PSF, visual acuity alone is not sufficient to assess all aspects of quality of vision.

More extensive and sensitive methods to test quality of vision are indicated in patients with subjective visual impairment and good visual acuity; however, in the past this was hindered by the lack of adequate and repeatable measurement methods.[5,7,13] Before the development of a reliable and clinically useful straylight instrument, efforts were focused on glare testers. These instruments usually assess visual acuity or contrast sensitivity with and without a glare source presented at an angular distance in the visual field. In this way, an outcome more or less related to straylight or disability glare was measured, but often with unreliable results, poor repeatability, and inadequate discriminative ability.[18] Subject bias and learning effects could not be excluded,[19] and the outcomes of these tests correlate poorly with validity measures such as questionnaires assessing patient-perceived visual disability[20,21] or directly measured forward light scatter.[18,21] These problems with the use of glare testers has prevented their widespread acceptance of a standard way to measure glare.[8]

Therefore, recent cataract surgery guidelines of the Royal College of Ophthalmologists[A] state that tests for contrast sensitivity, glare, laser interferometry, and specular photography are not of proven value. However, a computerized straylight meter, the C-Quant (Oculus GmbH), is reported to provide valid measurements and to be easy to use in a clinical setting.[10,22] It objectively assesses the amount of intraocular forward scattered light and provides reliable assessment because it is no longer possible to consciously influence the measurement outcome. It gives highly repeatable results for untrained subjects over a wide range of straylight values,[19,22] and there is no learning process involved in repeated measurements.[22] The device accurately measures the amount of intraocular straylight, allowing straylight assessment to be part of clinical and preoperative considerations.[10]

In this study, we used the National Eye Institute Visual Function Questionnaire-39 (NEI VFQ-39) and a straylight questionnaire to relate objective values, such as straylight and visual acuity, to patient-perceived visual function. The aims of this study were to determine whether visual acuity and straylight, both aspects of visual function, behave independently; to what degree visual acuity and straylight contribute to subjectively experienced quality of vision; and whether the involvement of straylight to the existing preoperative considerations (visual acuity) leads to a clearer indication for cataract extraction and an increased chance of postoperative improvement.

PATIENTS AND METHODS

Population

Patients were included according to the established criteria for elective cataract surgery at the participating hospitals. These included lens opacities consistent with cataract and justifying cataract extraction. Patients were recruited at Zonnestraal Eye Hospital, Hilversum, and the Department of Ophthalmology, Onze Lieve Vrouwe Gasthuis Hospital, Amsterdam, The Netherlands. The study complied with the tenets of the Declaration of Helsinki. All patients gave informed consent. Institutional review board approval was obtained at both sites. Patients were excluded if they had other ocular pathology, including decreased vision from

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causes other than cataract, or if they had laser refractive surgery.

Cataract extraction was performed in a similar fashion (phacoemulsification) at both sites and the Acrysof SN60WF (Alcon Laboratories, Inc.) was the standard intraocular lens (IOL) type. Because there were no statistically significant differences in age, sex, visual functioning, or operative procedure between patients at the 2 sites, the data were combined and analyzed together.

Measurement Procedure

Before and after cataract extraction, the corrected distance visual acuity (CDVA) and straylight values were recorded in all patients. The CDVA was tested using the Early Treatment Diabetic Retinopathy Study (ETDRS) chart[23,24] and is reported in logMAR notation. The C-Quant straylight meter was used to quantify the amount of retinal straylight. The amount of intraocular straylight is expressed as the logarithm of the straylight parameter s (log[s]); a higher straylight value indicates more sensitivity to glare. The straylight meter is a computerized instrument based on the psychophysical compensation-comparison method and has been described in detail.[10,19,25–27] In short, the compensation-comparison method uses a central test field divided into halves, 1 with and 1 without counter-phase compensation light and surrounded by a flickering ring. The flickering light of this ring is projected partly onto the retinal image of the central test field by intraocular light scattering and is perceived by the patient as (faint) flickering in the central test field. The added counter-phase compensation light can stop the flickering and causes a difference in modulation between the 2 central test fields. The patient's task is a forced-choice comparison to identify which half shows the strongest flicker. A psychometric response curve is computed from the patient's responses. A reference database was established in a large European multicenter study.[5,9,10] The test is reproducible,[19,22] and the instrument supplies a reliability index, called the estimated standard deviation, for each measurement. Measurements were included only when the estimated standard deviation was considered reliable (below 0.1). Each eye was measured twice.

Breakeven Point

The breakeven point is defined as the preoperative value at which the chance of improvement after cataract extraction is 50% (and chance of postoperative deterioration is also 50%). It can be acquired by calculating when the major axis regression value is zero. In our population having cataract surgery, the breakeven point was determined for visual acuity and straylight separately and also for overall vision (when both visual acuity and straylight are taken into account in the preoperative considerations).

Binocular Acuity and Binocular Straylight

Binocular visual acuity is better than the mean monocular value.[28] Binocular visual acuity is better than best monocular visual acuity by a mean of between 0.045 logMAR and 0.150 logMAR.[29,30] If the difference in monocular visual acuity between the right eye and the left eye is large, binocular visual acuity is not always better than the visual acuity in the best eye. In the present study, binocular visual acuity was considered to be equal to the visual acuity in the best eye when the difference in monocular visual acuity between the 2 eyes was greater than 0.10 logMAR. When the difference in monocular visual acuity of each eye was 0.10 logMAR or less, binocular acuity was considered equal to visual acuity in the best eye minus 0.10 logMAR. Straylight can only be measured in each eye separately, and a previous study[B] found that the binocular straylight value is approximately the mean of the straylight values in both eyes; that is, (value of right eye + value of left eye)/2.

Questionnaires

Patients completed the validated 39-item NEI-VFQ-39 and a straylight questionnaire to evaluate vision-related quality of life.[31,32] The NEI-VFQ-39 was developed to measure multiple aspects of vision-related functioning and to allow comparison of vision-related quality of life for various ocular disorders.[33] The NEI-VFQ-39 composite score is the mean of all vision-specific NEI-VFQ-39 scales (37 questions), excluding 2 questions concerning general health. To capture straylight symptoms, a 5-item questionnaire was designed based on clinical experience (Figure 1). Scores on both questionnaires were transformed to a range from 0 (maximum impairment) to 100 (no impairment). Both questionnaires were answered preoperatively and approximately 6 weeks after final surgery.

To determine the relative importance of straylight on quality of vision compared with visual acuity, binocular straylight and visual acuity were correlated with subjective assessments (questionnaire score) of the patients. The correlations were calculated with different weight ratios of straylight and visual acuity. In consecutive calculations, the ratio between straylight:visual acuity ranged from 64:1 to 1:64 for visual acuity and straylight, respectively. For example, if the visual acuity:straylight ratio was 64:1, the visual function was defined as 64 × visual acuity value + 1 × straylight

Straylight Questionnaire

1. How much difficulty do you experience seeing what is ahead of you when you drive into a tunnel during the daytime?
2. How much difficulty do you experience seeing what is ahead of you when an oncoming car has bright headlights on at night?
3. How much difficulty do you experience seeing what is ahead of you when a low sun is shining in your eyes during the daytime?
4. To what extent did you stop driving a car because of the above-mentioned problems?
5. How much difficulty do you experience recognizing faces against the light?

Figure 1. Five-item straylight questionnaire. All questions were answered on a scale from 0 to 5, except question 4, which had a "not applicable" answering option. Answers were 0 = none (20 points), 1 = hardly any difficulty (16 points), 2= mild difficulty (12 points), 3 = moderate difficulty (8 points), 4 = severe difficulty (4 points), and 5 = very severe difficulty (0 points). The score for this questionnaire was determined by adding the points from all questions, resulting in a total score between 0 and 100, where 0 was the worst possible score and 100 the best possible score.

value. The correlations between the questionnaires and the different visual acuity and straylight weight ratios were compared with the correlation value of the NEI-VFQ-39 and visual acuity (the gold standard) because the NEI-VFQ-39 is validated for its correlation with visual acuity in patients with age-related cataract.[31] Improvement or deterioration in the correlation values that took both straylight and visual acuity into account was compared with the correlation value that took only visual acuity into account. This gave an indication of the relative influence of straylight on quality of vision compared with the influence of visual acuity.

Statistical Analysis

Data were analyzed using statistical functions in Microsoft Office Excel 2003 software (Microsoft Corp.). Correlations were calculated using normal regression analysis. Regression lines plotted in the figures are the major axis regression lines.

RESULTS

The population consisted of 217 patients who had a preoperative assessment for cataract surgery (187 at Zonnestraal Eye Hospital; 30 at Onze Lieve Vrouwe Gasthuis Hospital) with a mean age of 72 years ± 9.12 (SD) (range 29 to 90 years). Cataract surgery was performed in both eyes of 129 patients (258 eyes). Surgery was performed in 1 eye of 62 patients, of which 12 were pseudophakic in the other eye. All cataract extractions were uneventful. Twenty-six patients did not have an operation because the treating ophthalmologist or patient decided cataract surgery was not yet indicated.

Relationship Between Visual Acuity and Straylight

A complete set of visual acuity and straylight data was available for 420 preoperative eyes. In keeping with the focus of this article (ie, to determine whether visual acuity and straylight behave independently), the preoperative data of all included eyes are shown in Figure 2. The mean straylight in the preoperative population was 1.55 ± 0.29 log(s) and the mean CDVA, 0.28 ± 0.21 logMAR. There was little correlation between visual acuity and straylight (R^2 = 0.08) (Figure 2). In Figure 2, the red lines divide the population into 4 subgroups as follows: (I) normal visual acuity and straylight; that is, no indication for surgery; (II) normal visual acuity, increased straylight; that is, straylight is the only indication for surgery; (III) deteriorated visual acuity, normal straylight; that is, visual acuity is the only indication for surgery; (IV) deteriorated visual acuity and increased straylight; that is, both visual acuity and straylight are indications for surgery. Figure 2 shows the preoperative data of all included eyes; the figure also contains data of study eyes that did not have cataract extraction.

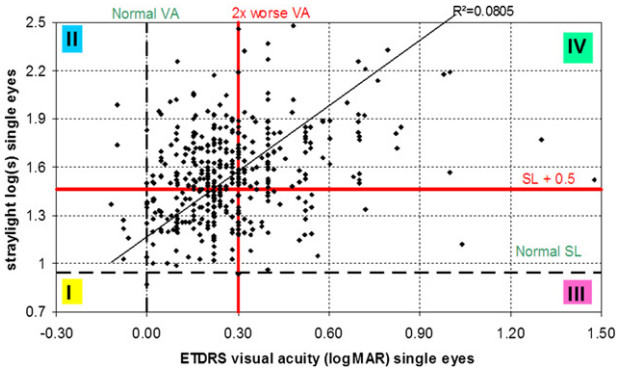

Figure 2. Straylight in log(s) as a function of visual acuity in logMAR of the preoperative population (420 eyes). The dashed lines represent the presumed normal visual acuity value of healthy eyes (0.00 logMAR; "normal visual acuity") and the normal straylight value of young healthy eyes (0.94 log[s]; "normal straylight"). The red lines represent the values of visual acuity (visual acuity = 0.30 logMAR; "2 × worse visual acuity") and straylight (straylight = 1.44 log[s]; "straylight +0.5"), when patients frequently start to experience serious hindrance from diminished visual functioning and cataract surgery could be indicated. These red lines divide the population in 4 subgroups as discussed in the Results section. The black line is the major axis regression line between visual acuity and straylight, R^2 = 0.08 (ETDRS = Early Treatment Diabetic Retinopathy Study; SL = straylight; VA = visual acuity).

Table 1. Mean preoperative and postoperative values and the postoperative improvement in CDVA (logMAR) and straylight (log(s)) for the 4 subgroups (based on indications for surgery). Only operated eyes for which all data were available are included (n = 309).

	Mean ± SD							
	Group I: Normal CDVA and SL (71 Eyes [23%])		Group II: Normal CDVA, Increased SL (106 Eyes [34%])		Group III: Deteriorated CDVA, Normal SL (32 Eyes [10%])		Group IV: Deteriorated CDVA, Increased SL (100 Eyes [32%])	
Parameter	CDVA <0.30	SL <1.44	CDVA <0.30	SL >1.44	CDVA >0.30	SL <1.44	CDVA >0.30	SL >1.44
Preop	0.18 ± 0.07	1.29 ± 0.11	0.19 ± 0.07	1.68 ± 0.17	0.42 ± 0.14	1.26 ± 0.14	0.47 ± 0.19	1.74 ± 0.21
Postop	0.01 ± 0.08	1.18 ± 0.24	0.00 ± 0.07	1.23 ± 0.07	0.04 ± 0.10	1.24 ± 0.18	0.03 ± 0.10	1.26 ± 0.20
Postop improvement	0.17 ± 0.10	0.11 ± 0.24	0.19 ± 0.09	0.44 ± 0.27	0.38 ± 0.18	0.01 ± 0.23	0.44 ± 0.22	0.48 ± 0.29

CDVA = corrected distance visual acuity; SL = straylight

Table 2. Mean preoperative and postoperative values and the postoperative improvement in the validated 39-item NEI VFQ and the straylight questionnaire in the 4 subgroups. Only operated eyes for which all data were available are included (n = 309).

	Mean ± SD							
	Group I: Normal CDVA and SL (71 Eyes [23%])		Group II: Normal CDVA, Increased SL (106 Eyes [34%])		Group III: Deteriorated CDVA, Normal SL (32 Eyes [10%])		Group IV: Deteriorated CDVA, Increased SL (100 Eyes [32%])	
Parameter	NEI VFQ	SLQ	VFQ	SLQ	VFQ	SLQ	VFQ	SLQ
Preop	80.3 ± 13.3	63.3 ± 15.9	79.8 ± 17.4	63.1 ± 15.6	80.6 ± 12.5	64.2 ± 18.7	78.6 ± 17.4	64.8 ± 19.2
Postop	91.1 ± 7.2	74.5 ± 17.0	93.3 ± 5.1	75.1 ± 16.8	93.3 ± 5.4	76.9 ± 21.5	89.5 ± 10.1	74 ± 20.9
Postop improvement	10.8 ± 9.9	10.4 ± 17.9	10.8 ± 10.1	11.6 ± 18.5	12.9 ± 12.1	12.8 ± 18.1	9.7 ± 10.5	8.2 ± 19.1

CDVA = corrected distance visual acuity; NEI VFQ = National Eye Institute Visual Function Questionnaire; SLQ = straylight questionnaire

Postoperative Improvement in Visual Acuity and Straylight

Table 1 shows the mean preoperative and postoperative values and the postoperative improvement in CDVA and straylight in the 4 subgroups of eyes that had cataract extraction (n = 309). Table 2 shows the mean preoperative and postoperative values and the postoperative improvement in the NEI-VFQ and the straylight questionnaire scores in the 4 subgroups (n = 309 eyes).

Figure 3 shows the postoperative improvement as a function of the preoperative value for straylight (ie, preoperative value minus postoperative value). Straylight improved in 211 eyes after surgery; however, it worsened in 32 eyes. Five eyes had no change. The mean postoperative improvement in straylight was 0.31 ± 0.32 log(s) (range −0.50 to 1.27) (R^2 = 0.57). For straylight, the breakeven point was a preoperative value of 1.29 log(s). The correlation between overall straylight measurements and the straylight questionnaire scores was $r = -0.26$, which was statistically significant ($P \leq .001$). In patients with preoperative normal visual acuity and increased straylight (Group II), the improved straylight correlated with an improvement in the postoperative visual quality questionnaire scores (change on NEI VFQ = 10.8; change on straylight questionnaire = 11.6). Both improvements were statistically significant ($P < .001$). However, the correlation coefficient between the postoperative straylight improvement and each of the results did not reach significance.

The postoperative CDVA improved in 247 eyes, did not change in 3 eyes, and worsened in 8 eyes. The mean postoperative improvement in CDVA was 0.26 ± 0.20 logMAR (range −0.12 to 1.12 logMAR). The coefficient of the relation improvement logMAR – preoperative logMAR (ie, improvement logMAR versus preoperative logMAR) was R^2 = 0.58. The breakeven point for visual acuity was a preoperative visual acuity of 0.06 logMAR.

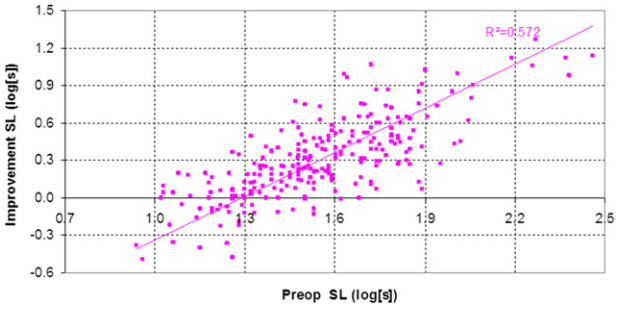

Figure 3. Postoperative improvement in straylight as a function of preoperative straylight values. Each eye plotted (n = 258) is from patients who had surgery in both eyes (SL = straylight).

Visual Function: Visual Acuity and Straylight

Figures 4 and 5 show the relative correlation between the NEI VFQ-39 and the straylight

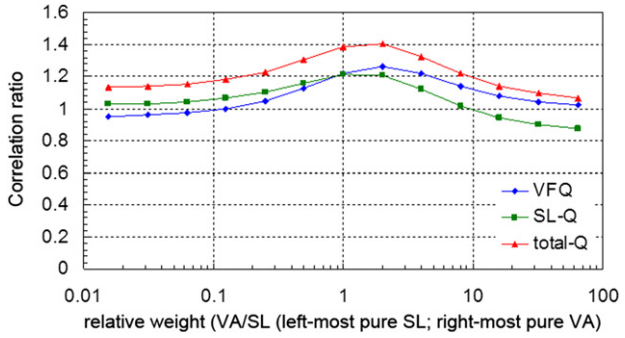

Figure 4. The relative correlation between questionnaires (NEI VFQ = *diamonds*, SL-Q = *squares*, NEI VFQ + straylight = *triangles*) and relative weight of (binocular visual acuity + straylight) as a function of relative weight of (binocular visual acuity + straylight) in the preoperative situation (n = 201). The correlation values have been normalized to the correlation between NEI VFQ-39 and visual acuity. Note that the *y*-axis represents relative *R* values because all *R* values have been normalized to the *R* value between visual acuity and NEI VFQ-39. The maximum in correlation ratio is found when visual acuity and straylight are counted about equally (1:1) and the 2 questionnaires are combined (correlation ratio = normalized to NEI VFQ versus visual acuity; Q = questionnaire; SL = straylight; VA = visual acuity).

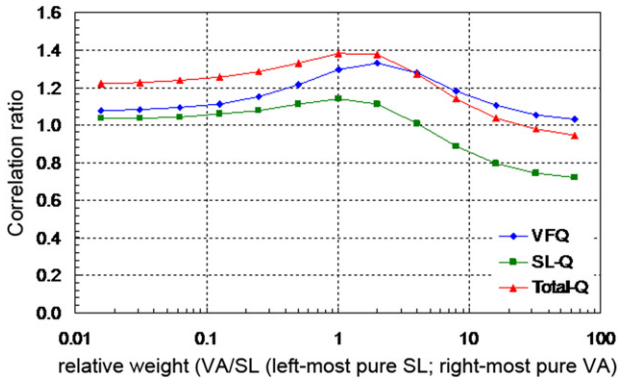

Figure 5. The relative correlation between questionnaires (NEI VFQ = *diamonds*, straylight questionnaire [SL-Q] = *squares*, NEI VFQ + straylight = *triangles*) and relative weight of (binocular visual acuity + straylight) as a function of relative weight of (binocular visual acuity + straylight) in the postoperative situation (n = 147). The correlation values have been normalized to the correlation between NEI VFQ-39 and visual acuity. Note that the *y*-axis represents relative *R* values because all *R* values have been normalized to the *R* value between visual acuity and NEI VFQ-39. The maximum in correlation ratio is found when visual acuity and straylight are counted approximately equally and the 2 questionnaires are combined (correlation ratio = normalized to NEI VFQ versus visual acuity; Q = questionnaire; SL = straylight; VA = visual acuity).

questionnaires. In Figures 4 and 5 at × = 1, straylight and visual acuity are weighed equally (1:1). Each step to the left doubles the weight of the straylight value compared with the visual acuity value (2:1, 4:1, 8:1, 16:1, 32:1, and 64:1), and each step to the right doubles the weight of the visual acuity value compared with that of the straylight value. In Figures 4 and 5, a *y*-value of 1 indicates that the correlation is the same as the correlation between NEI VFQ-39 and visual acuity. A *y*-value larger than 1 indicates that the correlation between the different weight ratios of visual acuity and straylight with the questionnaires is better than the correlation between NEI VFQ-39 and visual acuity, meaning that the level of subjective visual functioning can be better assessed when straylight is also taken into account, as well as visual acuity.

Figure 4 shows the different correlations for all preoperative patients who completed both the NEI VFQ and straylight questionnaires and had visual acuity and straylight measurements (201 patients). The maximum in correlation ratio is found when straylight and visual acuity are taken into account at a ratio between 1:1 and 1:2. The different correlations for all postoperative patients who completed both the NEI VFQ and straylight questionnaire and had visual acuity and straylight measurements (147 patients) are shown in Figure 5. The maximum in correlation ratio is found when straylight and visual acuity are taken into account at a ratio between 1:1 and 1:2.

Postoperative Improvement in Overall Vision

Figure 6 shows the postoperative improvement in the combined straylight and visual acuity value as a function of the preoperative combined straylight and visual acuity values in both eyes of patients who had bilateral surgery. The mean improvement in overall vision was 0.35 ± 0.16 log (range −0.09 to 0.77 log), which is more than the mean improvement in straylight and visual acuity separately (R^2 = 0.59). All patients except 2 had improved overall vision. The breakeven point for overall vision was a preoperative value of 0.65 log.

DISCUSSION

The results in this study show that straylight and visual acuity behave quite independently and that each contributes to the overall quality of vision. Preoperatively and postoperatively, straylight and visual acuity contributed a nearly equal amount to subjectively experienced quality of vision, as documented by the NEI VFQ-39 and straylight questionnaire scores. After cataract surgery, the mean visual acuity and straylight improved (by 0.26 logMAR and 0.31 log[s], respectively); however, improvement in overall vision (taking both visual acuity and straylight into account) exceeded that of visual acuity and straylight separately (0.35). To better predict postoperative improvement after cataract surgery, we believe straylight measurement would be a clinically useful tool.

Studies[1,2] have shown improved visual acuity after cataract surgery. In our study, visual acuity improved in the majority of eyes. However, the time and energy spent on determining the best possible refraction are likely to be less preoperatively than postoperatively. This misbalance may lead to overestimation of the effect of surgery. Eyes that did not improve or even deteriorated postoperatively usually had good preoperative visual acuity. Quintana et al.[2] found that

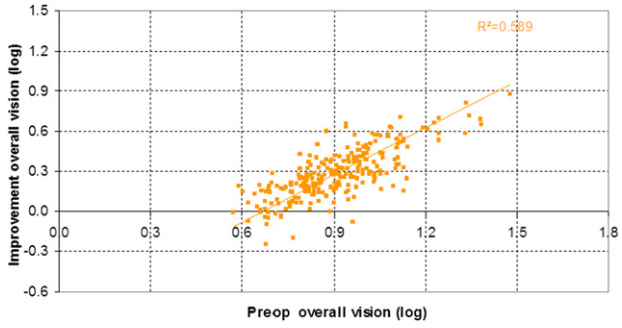

Figure 6. Improvement in overall vision [(binocular visual acuity + binocular straylight)/2] as a function of preoperative overall vision. Each plotted eye (n = 258) is from patients who had surgery in both eyes.

preoperative visual acuity is a significant predictor of postoperative visual acuity. Furthermore, they also showed that patients with good preoperative visual acuity (>0.6 Snellen) were inappropriate candidates for cataract surgery because the predicted postoperative improvement in visual acuity was not significant.[2] The results in this study show that eyes with impaired visual acuity have a significant chance of improvement. In our population, it was possible to determine a breakeven point value of 0.06 logMAR, which corresponds to Snellen acuity of 20/22; eyes with better preoperative visual acuity had little or no postoperative improvement.

Opacification of the crystalline lens does not only influence visual acuity, it also increases the amount of intraocular straylight.[5,6,9,10,14,16] By removing the cataract and replacing it with a clear IOL, straylight levels might be expected to improve to levels in young healthy eyes (0.94 log[s]).[9,10] Studies[9,10] report significant differences in straylight values between eyes with cataract and pseudophakic eyes. In most eyes in our population, cataract surgery significantly improved straylight and visual acuity values, although a substantial number of patients had a deterioration in straylight after surgery. The mean postoperative straylight in our patients who had surgery in both eyes was 1.22 log(s). The reason some pseudophakic eyes deteriorate in straylight postoperatively or do not improve to the extent in young healthy eyes is unknown, and further research is necessary. A possible explanation is that in elderly eyes, in addition to opacification of the crystalline lens, several other factors contribute to straylight, such as increased scattering in other optical parts of the eye (cornea or vitreous), the effects of the IOL or the remaining lens capsule, increased transmission of light through the iris and sclera by age-related pigmentation changes, and reflection of light on the fundus by loss of melanin in the retinal pigment epithelium.[9,10,16] These contributions to straylight remain present after cataract surgery; therefore, improvement that reaches the straylight level in the young healthy eye may not always be achieved.[9] Increased postoperative straylight levels can also be caused by intraoperative or postoperative complications, such as residual posterior capsule opacification, intraoperative iris trauma, or persistent corneal edema.[34,35] However, in our study population, these complications were absent. In a considerable number of our eyes, the straylight level increased compared with preoperative values, which can only be attributed to the surgical intervention. Perhaps other components of the eye did not respond well to surgery in these cases.

Postoperative straylight improved in 85% of our population. The correlation coefficient ($R^2 = 0.57$) showed that high straylight values preoperatively predicted significant improvement after cataract extraction. In eyes with normal to low straylight values, no or slight improvement is expected. Most eyes with deteriorated straylight had a low preoperative straylight value (<1.44 log**(s)**). In this study, a classic decision-making process involving only visual acuity and not involving straylight was used to determine whether to perform surgery. This may explain why visual acuity improved in a relatively high number of cases in our study. If straylight were used as an inclusion criterion, the same may be expected for straylight.

When visual acuity and straylight are combined as overall visual function in the preoperative condition, 10% of eyes deteriorated postoperatively. This must be compared with the 4% and 15% of eyes that showed no change or deterioration in postoperative visual acuity and straylight, respectively. Preoperative selection of patients in this study was based exclusively on visual acuity, which explains the good postoperative visual acuity result. However, this study has shown that overall visual function entails more than just visual acuity and that straylight must also be taken into account when considering quality of vision. Neither straylight nor overall visual function was a preoperative consideration in our population. When these are considered, the postoperative results show that a relatively large proportion of the population did not benefit from cataract extraction. Preoperative predictability of a good functional outcome will increase when overall visual function (ie, both visual acuity and straylight) is taken into account instead of visual acuity only because if no improvement in straylight occurs, it may occur in visual acuity and vice versa, resulting in improved postoperative overall visual function.

So what to do with patients with cataract and good preoperative visual acuity who still have subjective visual complaints? These patients may require more extensive preoperative counseling because visual acuity measurement alone often is insufficient to fully understand the patient's symptoms.[3–5,7,9,10,12,13] Cataract extraction in these patients might still be considered if there is another form of visual impairment, such as an increased straylight level.

The decision when to perform cataract surgery involves clinical examination, additional research, and evaluation of patient complaints. Nonetheless, regional variations in the rate of cataract extraction exist.[1–4] It is often uncertain which thresholds or vision tests are used in surgical decision making.[3] A study by Quintana et al.[2] attempted to identify appropriate patients for cataract extraction by creating decision trees based on preintervention visual acuity and surgical complexity. However, the discriminative ability of those models remained modest, suggesting that other factors that were not included in the models also play important roles.[2]

Our study aimed to determine an additional objective parameter that would be useful in the preoperative decision-making process to improve the chance of good postoperative results. Breakeven points for visual acuity, straylight, and overall vision were determined. For clinical purposes, a 50% chance of improvement might not be enough to merit performing surgery because the expected benefits of an intervention have to exceed its risks and complications by a sufficiently wide margin to justify performing it (RAND definition).[2] However, the breakeven point can be adjusted according to the desired postoperative outcome. For example, the aim can be at least a 50% chance of improving 2 lines on a letter chart. Each improvement of 1 line on an ETDRS letter chart equals 0.10 logMAR improvement; thus, an improvement in visual acuity of 0.20 logMAR would be required. Therefore, the preoperative visual acuity should be 0.24 logMAR or worse. The same can be calculated for straylight; when preoperative straylight is 1.46 log(s), a 50% chance of 0.2 log(s) improvement can be expected. For overall vision, a preoperative value of 0.79 log predicts a 50% chance of 0.2 log improvement after surgery. In this way, preoperative vision values can be used to predict postoperative visual outcomes.

To conclude, at present, preoperative considerations regarding cataract extraction are mainly based on distance visual acuity[1–3,7]; patient-perceived visual function may also be an important consideration.[1,2,7] Subjective visual function can improve after cataract surgery even when the preoperative visual acuity is 20/20 (0.00 logMAR) or better. This is because visual function is determined not only by visual acuity but also by other independent parameters (eg, straylight).[5–7,9,10,13,14] However, for an additional objective value to be of use for clinicians in the preoperative decision-making process, it has to be clinically relevant, scientifically valid, standardized, easy to measure, and correlate with the patient's symptoms.[2,3,13] Straylight is assessed easily in the clinic and was found to contribute nearly the same amount as visual acuity to subjective visual quality of life preoperatively and postoperatively, as measured by questionnaires. Straylight measurements are objective, while visual acuity measurements are more subjective and can be influenced by stimulating the patient and the accuracy of refraction. The results in our study indicate that using straylight in addition to visual acuity will improve the preoperative decision-making process for cataract surgery.

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