Acta Med. Okayama, 2012
Vol. 66, No. 2, pp. 101–110

Acta Medica Okayama
http://escholarship.lib.okayama-u.ac.jp/amo/

Original Article

Comparison of VF-14 Scores among Different Ophthalmic Surgical Interventions

Fumiko Kishimoto[a,b]*, and Hiroshi Ohtsuki[a]

[a]*Department of Ophthalmology, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama 700–8558, Japan,*
[b]*Division of Ophthalmology, Ibara Municipal Hospital, Ibara, Okayama 715–0019, Japan*

To clarify surgical outcomes for 5 ophthalmic diseases in terms of vision-related quality of life (QOL), we sent a self-administered Visual Function Questionnaire-14 (VF-14) to patients 3 months postoperatively, and the VF-14 scores for the surgical outcome of strabismus were compared with those of patients with diabetic macular edema (DME), cataract, glaucoma, and epiretinal membrane (ERM). Test-retest repeatability of VF-14 was evaluated with Bland-Altman analysis. Of the 625 eligible patients who were referred for enrollment, 48 with comitant strabismus, 50 with incomitant strabismus, 45 with DME, 38 with cataract, 129 with glaucoma, and 73 with ERM agreed to answer. Eighty percent of subjects showed 95% limits of agreement with the VF-14 evaluated by repeated measurements. The gain by surgery for incomitant strabismus was not different from that of cataract ($p = 0.5551$), but it was significantly better than those of DME ($p = 0.0266$), comitant strabismus ($p = 0.0128$), ERM ($p = 0.0021$), glaucoma with cataract ($p < 0.0001$), and glaucoma alone ($p < 0.0001$). The surgical outcome in terms of QOL for patients with incomitant strabismus was good and comparable to that of patients with cataract surgery.

Key words: visual function questionnaire, VF-14, ophthalmic disease, surgical intervention, gain

The importance of evaluating the outcome of medical care from the patients' viewpoint has been increasingly recognized. This patient-oriented outcome is characterized by the quantification of changes in the health-related quality of life (QOL) following treatment [1]. Examples are the Medical Outcomes Study 36-item Short Form (SF-36), the Sickness Impact Score (SIP), and utility analysis with typical comprehensive scales for QOL assessment without restricting the subjects to patients with a particular disease. In the field of ophthalmology, various vision-related disease-specific scales have been developed to evaluate impairment of visual function and therapeutic effects from the patients' viewpoint. Representative examples are the Visual Function Questionnaire (VF)-14 and the National Institute Visual Function Questionnaire (NEI VFQ)-25, which are widely used [2].

In recent years, strabismus, an impairment in visual function, and the sociopsychological problems characteristic of this disease have become recognized, and tools including the Amblyopia & Strabismus Questionnaire (A&SQ) [3] and the 20-item Adult Strabismus Quality of Life Questionnaire (AS-20) [4, 5] have been developed to analyze them from the viewpoint of QOL. Furthermore, methods to evaluate

Received April 26, 2011; accepted November 2, 2011.
*Corresponding author. Phone:+81–866–62–1133; Fax:+81–866–62–1275
E-mail:fumiko-k@mvf.biglobe.ne.jp (F. Kishimoto)

treatments for strabismus by QOL measurement according to their economic efficiency using cost-effect analysis are attracting attention [6, 7]. In particular, the socioeconomic disadvantages and psychological effects of adult strabismus have come to be perceived as problems [8, 9], and there have been reports on various QOL assessments, typically using NEI VFQ-25 [3, 4]. In Japan, there has also been multi-center joint research analyzing the effect of strabismus surgery on QOL using NEI VFQ-25 [7].

VF-14 is a method for assessing the quality of the visual function of those with cataracts in daily living from the patients' viewpoint, developed in 1994 by Steinberg *et al.* [10]. Its advantage is that it consists of fewer questions and can be performed in a shorter time than NEI VFQ-25. In addition, VF-14 shows a close correlation with visual acuity [2, 10, 11, 12] and has been reported to be correlated with the presence or absence of other ophthalmic or systemic disorders [10], depth perception [12], and contrast sensitivity [12]. Using VF-14, we compared the effects of surgery for comitant and incomitant strabismus on vision-related QOL with those of surgical treatments for major ophthalmic diseases including diabetic macular edema (DME), cataract, glaucoma, and epiretinal membrane (ERM), because there were no comparative visual function scores available after these various ophthalmic surgical interventions.

Subjects and Methods

Participants. A total of 625 patients who underwent surgery at Okayama University Hospital between 2005 and 2008, aged 40 to 85 years, were examined with the self-administered VF-14. Thirty-seven normal subjects, aged 40 or older, were used as a control. Members of the control group showed decimal corrected visual acuity of 1.0 or more in both eyes and had never been diagnosed with any ophthalmic disease.

This study was carried out with the approval of the Ethical Review Board of the Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences.

Measurements. VF-14 consists of 14 questions related to behavioral patterns in daily living that are likely to be affected by vision (Table 1), and the respondents chose one of 5 capability levels from 'not capable at all' to 'perfectly capable'. The answers were weighted by scoring 'not capable at all' as 0 and 'perfectly capable' as 4, the total score of the 14 items was divided by the number of questions answered, and the quotient was multiplied by 25 to calculate the total score. The total score was 100 if the answers to all questions were 'perfectly capable' and 0 if the answers to all questions were 'not capable at all'. Six items related to binocular vision were chosen from 14 items of VF-14, the score calculated employing the same methods concerning the 6 items was determined as binocular vision score (Table 1). The difference in the

Table 1 Visual function questionnaire-14 (VF-14)

1.	Do you have any difficulty, even with glasses, reading small print, such as labels on medicine bottles, a telephone book, or food labels?
2.	Do you have any difficulty, even with glasses, reading a newspaper or a book?
3.	Do you have any difficulty, even with glasses, reading a large-print book or large-print newspaper or the number on a telephone?
4.	Do you have any difficulty, even with glasses, recognizing people when they are close to you?
5.*	Do you have any difficulty, even with glasses, seeing steps, stairs, or curbs?
6.	Do you have any difficulty, even with glasses, reading traffic signs, street signs, or store signs?
7.*	Do you have any difficulty, even with glasses, doing fine handwork like sewing, knitting, crocheting, or carpentry?
8.	Do you have any difficulty, even with glasses, writing checks or filling out forms?
9.	Do you have any difficulty, even with glasses, playing games such as bingo, dominos, card games, or mahjong?
10.*	Do you have any difficulty, even with glasses, taking part in sports like bowling, handball, tennis, or golf?
11.*	Do you have any difficulty, even with glasses, cooking?
12.*	Do you have any difficulty, even with glasses, watching television?
13.*	How much difficulty do you have driving during the day because of your vision?
14.*	How much difficulty do you have driving at night because of your vision?

*Item used to calculate the binocular vision score.
Steinberg EP, *et al*. Arch Ophthalmol, 112, 630–638, 1994.

pre- and postoperative scores in patients with each disease was regarded as the gain following surgery for that disease.

For cataracts, the lens was removed by phacoemulsification and an intraocular lens was implanted. For DME and ERM, vitrectomy was performed followed by 20-gauge three-port pars plana vitrectomy. The crystalline lens was removed by phacoemulsification, and an intraocular lens was implanted when required. Glaucoma patients were divided into those who underwent glaucoma surgery by trabeculectomy with or without cataract surgery, and the scores were compared.

For comitant and incomitant strabismus, ocular deviation was measured, and the Bagolini striated glasses (BSG) test and Titmus stereo test were performed before and after surgery. Patients were instructed to gaze at a fixed object at a distance of 5 m, and ocular deviation in the primary position was measured with the prism and alternate cover test. Values were converted from prism diopters to degrees for statistical processing.

Evaluation of repeatability. Test-retest repeatability of VF-14 was analyzed using a Bland-Altman plot [13, 14] in 15 patients with comitant or incomitant strabismus, in whom VF-14 was performed 2 times at intervals of 1 to 3 months before surgery.

Statistical analysis. Using a non-parametric test, pre- and postoperative VF-14 and binocular scores were compared, and these were also compared with control subjects. In the same way, the gain from surgical intervention was compared between patients with incomitant strabismus and those with other diseases. Multiple regression analysis was used to analyze relationships between the gain in VF-14 scores following the strabismus surgery and other variables that affect VF-14 scores. Analyses were carried out using the statistical software JMP (ver. 8.0 SAS Institute, Inc., NC, USA). $P < 0.05$ was considered significant.

Results

Of the 625 patients, 383 (61.3%), including 48 patients with comitant strabismus, 50 with incomitant strabismus, 45 with DME, 38 with cataract, 129 with glaucoma, and 73 with ERM, agreed to answer VF-14 (Table 2). The response rates were 67.2% with comitant and incomitant strabismus, 52.5% with DME, 41% with cataract, 72.8% with glaucoma, and 58.7% with ERM. Eighty percent of subjects showed 95% limits of agreement with the VF-14

Table 2 Subject age and gender

Disease	Number of patients	Age	Gender
		Mean ± SD (Median, Range)	Male Number (%) Female Number (%)
DME	45	68.0 ± 9.0 (69, 42 to 82)	23 (51.1) 22 (48.9)
Cataract	38	72.0 ± 6.8 (74, 52 to 84)	16 (42.1) 22 (57.9)
Incomitant strabismus	50	64.5 ± 10.6 (66, 40 to 87)	25 (50.0) 25 (50.0)
Glaucoma alone	57	70.1 ± 11.2 (72, 47 to 88)	33 (57.9) 24 (42.1)
Glaucoma (with cataract)	72	73.8 ± 6.8 (74, 55 to 89)	34 (47.2) 38 (52.8)
ERM	73	70.2 ± 8.4 (71, 49 to 86)	36 (49.3) 37 (50.7)
Comitant strabismus	48	56.6 ± 13.1 (54, 40 to 84)	20 (41.7) 28 (58.3)
Normal	37	59.2 ± 8.4 (60, 40 to 73)	25 (67.6) 12 (32.4)

DME, Diabetic macular edema; ERM, Epiretinal membrane.

evaluated by repeated measurements (Table 3, Fig. 1).

Of 14 questionnaires, the pre- and postoperative mean number (SD) of responses was 12 (2). Of 6 questions related to binocular visual function, the pre and postoperative mean numbers (SD) of responses were 4 (1) and 4 (2), respectively. The preoperative VF-14 scores were significantly different among diseases ($p<0.0001$; Kruskal-Wallis test). Mean preoperative VF-14 scores were 57 with DME, 62 with cataract, 67 with incomitant strabismus, 73 with glaucoma surgery alone, 74 with glaucoma combined with cataract surgery, 76 with ERM, 80 with comitant strabismus, and 90 with normal control. VF-14 scores of the ophthalmic diseases were significantly lower than those of the normal control ($p=0.005$ for comitant strabismus, $p<0.0001$ for incomitant strabismus, DME, cataract, glaucoma, and ERM; Wilcoxon rank sum test). The scores of comitant strabismus were significantly higher than those of cataract and DME ($p=0.0002$ in cataract, $p<0.0001$ in DME; Wilcoxon rank sum test). The scores of incomitant strabismus was significantly lower than those of comitant strabismus, ERM, glaucoma surgery alone, and glaucoma with cataract surgery ($p=0.0003$ in comitant strabismus, $p=0.0021$ in ERM, $p=0.0111$ in glaucoma with cataract surgery, $p=0.0491$ in glaucoma surgery alone; Wilcoxon rank sum

Table 3 VF-14 and binocular vision scores before and after surgery

Disease	VF-14 score		Binocular vision score	
	Before surgery	After surgery	Before surgery	After surgery
	Mean ± SD Median (Range)	Mean ± SD Median (Range)	Mean ± SD Median (Range)	Mean ± SD Median (Range)
DME	57 ± 27 61 (4 to 94)	66 ± 24 67 (11 to 100)	59 ± 31 63 (0 to 100)	71 ± 27 75 (8 to 100)
Cataract	62 ± 22 63 (10 to 100)	84 ± 16 91 (54 to 100)	64 ± 24 75 (6 to 100)	84 ± 19 90 (33 to 100)
Incomitant strabismus	67 ± 18 65 (29 to 100)	85 ± 14 88 (50 to 100)	64 ± 20 65 (25 to 100)	83 ± 16 85 (25 to 100)
Glaucoma alone	73 ± 22 76 (5 to 100)	69 ± 25 70 (4 to 100)	73 ± 23 75 (8 to 100)	68 ± 26 71 (0 to 100)
Glaucoma (with cataract)	74 ± 20 79 (4 to 100)	77 ± 19 80 (21 to 100)	74 ± 23 80 (4 to 100)	75 ± 21 75 (17 to 100)
ERM	76 ± 17 79 (4 to 100)	82 ± 16 85 (8 to 100)	77 ± 19 79 (5 to 100)	82 ± 17 83 (6 to 100)
Comitant strabismus	80 ± 17 8 4(46 to 100)	88 ± 13 93 (55 to 100)	77 ± 19 82 (35 to 100)	87 ± 14 92 (38 to 100)
Normal	90 ± 10 93 (59 to 100)		92 ± 9 95 (65 to 100)	

DME, Diabetic macular edema; ERM, Epiretinal membrane.

test) (Table 3, Fig. 2).

The postoperative VF-14 scores were significantly different among diseases ($p<0.0001$; Kruskal-Wallis test). The mean postoperative VF-14 scores were 66 with DME, 69 with glaucoma surgery alone, 77 with glaucoma combined with cataract surgery, 82 with ERM, 84 with cataract, 85 with incomitant strabismus, and 88 with comitant strabismus. Postoperative VF-14 scores increased significantly compared to those of preoperative scores except for glaucoma. The postoperative VF-14 scores of strabismus and cataract surgery did not significantly differ from normal controls, but the scores of comitant strabismus were significantly higher than those of ERM ($p=0.0202$), glaucoma combined with cataract surgery ($p=0.0008$), glaucoma surgery alone ($p<0.0001$), and DME ($p<0.0001$; Wilcoxon rank sum test). The scores of incomitant strabismus were significantly higher than those of glaucoma combined with cataract surgery ($p=0.0163$), glaucoma surgery alone ($p=0.0002$), and DME ($p<0.0001$; Wilcoxon rank sum test) (Table 3, Fig. 2).

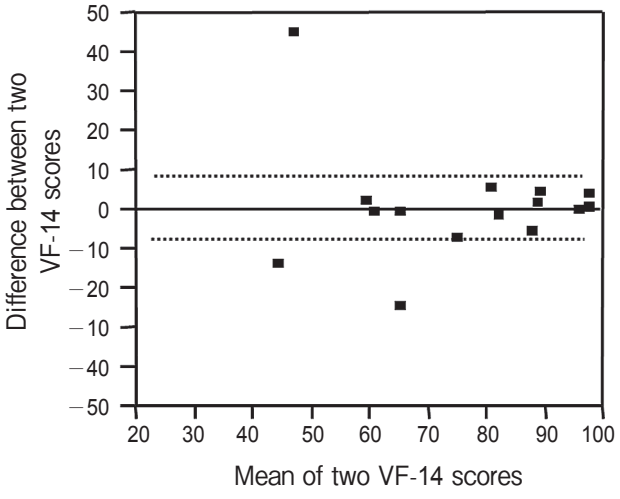

Fig. 1 Test-retest repeatability of VF-14. Bland-Altman plots showed that test-retest repeatability in the answers to the VF-14 was good ($p=0.9225$). Eighty percent of subjects showed 95% limits of agreement with the VF-14. The horizontal line indicates the mean, and the vertical line indicates the difference between two VF-14 scores measured at 2 different times, while the dotted line indicates the 95% limits of agreement (=mean difference $\pm 1.96 \times$ SD of the differences).

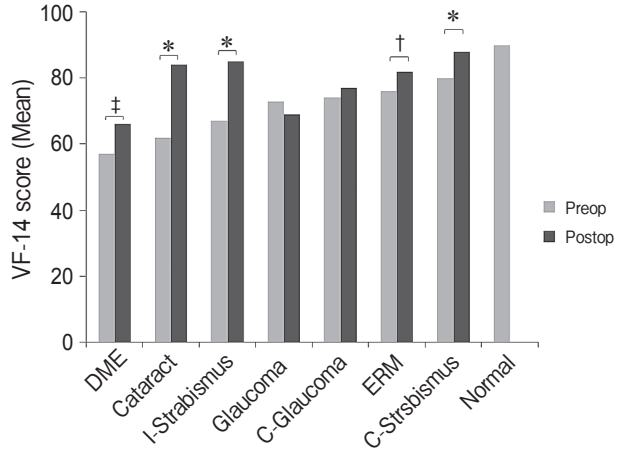

Fig. 2 Preoperative and postoperative VF-14 scores. DME, diabetic macular edema; I-Strabismus, incomitant strabismus; C-Glaucoma, glaucoma (with cataract) ERM, epiretinal membrane; C-Strabismus, comitant strabismus. $^{*}p<0.0001$, $^{\dagger}p<0.001$, $^{\ddagger}p<0.05$, Wilcoxon signed rank test.

The binocular vision scores also increased significantly postoperatively, except in those with glaucoma. The preoperative VF-14 and binocular vision scores were compared in each disease. In comitant strabismus, the binocular vision score was significantly lower than the VF-14 score ($p=0.0039$, Wilcoxon signed-rank test). However, no significant difference was noted between the 2 scores in other diseases, including incomitant strabismus. Postoperatively, no significant difference was noted between the 2 scores in comitant and incomitant strabismus ($p=0.2909$ in comitant strabismus, $p=0.4284$ in incomitant strabismus; Wilcoxon signed-rank test) (Table 3).

The gain in VF-14 scores was significantly different among diseases ($p<0.0001$; Kruskal-Wallis test). The mean gains in VF-14 score were 22 with cataract, 19 with incomitant strabismus, 9 with DME, 8 with comitant strabismus, 6 with ERM, 3 with glaucoma combined with cataract surgery, and -4 with glaucoma surgery alone. The gain following surgery for incomitant strabismus was not different from that for cataract surgery ($p=0.5551$, Wilcoxon rank sum test), but it was significantly larger than those for DME ($p=0.0266$), comitant strabismus ($p=0.0128$), ERM ($p=0.0021$), glaucoma combined with cataract surgery ($p<0.0001$), and glaucoma surgery alone ($p<0.0001$, Wilcoxon rank sum test). The gain in the score for comitant strabismus was not different from that for DME ($p=0.7062$), ERM ($p=0.6993$), or glaucoma combined with cataract surgery ($p=0.1185$), but it was significantly smaller than that for cataract

surgery ($p = 0.0034$) and significantly larger than that for glaucoma surgery alone ($p < 0.0001$, Wilcoxon rank sum test) (Fig. 3).

In the patients with glaucoma, a significant negative correlation was observed between the preoperative VF-14 score and age. However, no significant correlation was noted in any other disease or control (Table 4). A significant negative correlation was observed between the preoperative VF-14 score and gain in each disease (Table 5). Gender did not affect preoperative or postoperative VF-14 scores or gain in any disease either, except for preoperative VF-14 score in comitant strabismus (Tables 4 and 5).

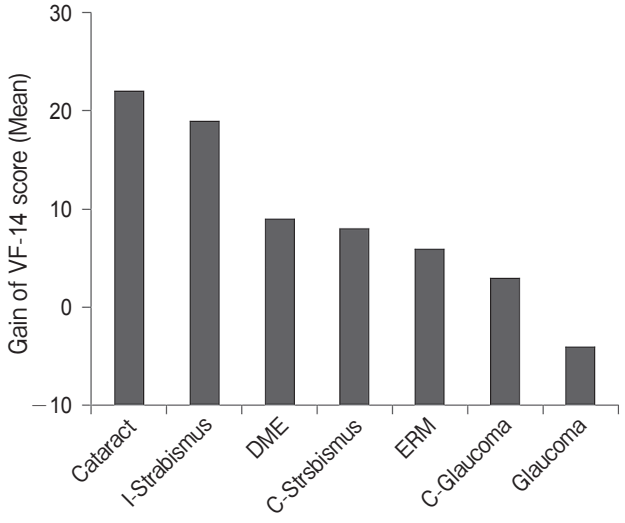

Fig. 3 The gains in VF-14 scores. The gains in VF-14 scores significantly differed among diseases. I-Strabismus, incomitant strabismus; DME, diabetic macular edema; C-Strabismus, comitant strabismus; ERM, epiretinal membrane; C-Glaucoma, glaucoma (with cataract). $p < 0.0001$, Kruskal-Wallis test.

The gain following surgery for comitant strabismus differed by type of strabismus, but that for incomitant strabismus did not differ (Table 6). In both comitant and incomitant strabismus, ocular deviation decreased and binocular function improved after surgery (Table 7). Multiple regression analysis showed that the significant independent variables that could affect postoperative results were age, preoperative VF-14 score, the type of strabismus, and postoperative diplopia for comitant strabismus, and preoperative VF-14 score, preoperative diplopia, postoperative diplopia, type of strabismus, and postoperative ocular deviation for incomitant strabismus (Table 8).

Discussion

A notable difference between patients with comitant strabismus and those with incomitant strabismus clarified by VF-14 was a low preoperative VF-14 score in only those with incomitant strabismus, despite visual acuity impairment not being a chief complaint in either comitant or incomitant strabismus compared with complaints in other diseases, while visual acuity characteristically shows a positive correlation with VF-14 score [2, 10, 11]. Second, the preoperative binocular vision score was significantly lower than the VF-14 score in patients with comitant strabismus, but there was no significant difference between these 2 postoperative scores. Third, the gain following surgery for incomitant strabismus was the

Table 4 Relationships between the preoperative VF-14 score and age and gender

	Age		Gender	
Disease	r	*p*-value	VF-14 score, Mean (Male, Female)	*p*-value
DME	−0.1194	0.4347	(55, 59)	0.4957
Cataract	0.2365	0.1529	(61, 63)	0.6047
Incomitant strabismus	−0.1590	0.2701	(68, 65)	0.5219
Glaucoma alone	−0.4054	0.0018*	(74, 71)	0.4470
Glaucoma (with cataract)	0.0663	0.5798	(76, 73)	0.5959
ERM	−0.0868	0.4655	(74, 78)	0.3179
Comitant strabismus	−0.2778	0.0559	(75, 84)	0.0423†
Normal	0.0767	0.6516	(91, 89)	0.7191

DME, Diabetic macular edema; ERM, Epiretinal membrane.
*$p < 0.05$, Spearman's rank correlation coefficient. †$p < 0.05$, Wilcoxon rank sum test.

Table 5 Relationships between the gain of VF-14 score and age, gender, preoperative VF-14 score

Disease	Age		Gender		Preoperative VF-14 score	
	r	*p*	Gain, mean (Male, Female)	*p*	r	*p*
DME	0.0845	0.5809	(15, 4)	0.1731	−0.5491	<0.0001†
Cataract	−0.2534	0.1248	(19, 24)	0.4063	−0.6038	<0.0001†
Incomitant strabismus	0.1058	0.4647	(18, 19)	0.8234	−0.7324	<0.0001†
Glaucoma alone	0.1233	0.3608	(−4, −5)	0.9612	−0.3233	0.0142†
Glaucoma (with cataract)	−0.0641	0.5926	(2, 3)	0.7222	−0.4867	<0.0001†
ERM	−0.0770	0.5204	(6, 6)	0.6481	−0.5897	<0.0001†
Comitant strabismus	0.4790	0.0006*	(9, 7)	0.4013	−0.6969	<0.0001†

DME, diabetic macular edema; ERM, epiretinal membrane.
*$p < 0.05$, Spearman's rank correlation coefficient. †$p < 0.05$, Wilcoxon rank sum test.

Table 6 Type of strabismus, VF-14 score, and the gain of VF-14 score

	No. of patients	Preoperative VF-14 score (Mean ± SD)	Postoperative VF-14 score (Mean ± SD)	Gain of VF-14 score (Mean ± SD)
Comitant strabismus				
Intermittent exotropia	19	81 ± 17	91 ± 10	9 ± 14
Constant exotropia	11	85 ± 17	88 ± 13	3 ± 10
Esotropia	8	69 ± 13	90 ± 10	21 ± 6
Consecutive exotropia	7	81 ± 18	78 ± 19	−3 ± 9
Sensory exotropia	2	96 ± 3	95 ± 4	−1 ± 14
Vertical strabismus	1	57	68	11
p-value		0.1013	0.5414	0.0004*
Incomitant strabismus				
Decompensated SOP	16	72 ± 17	85 ± 15	13 ± 13
Thyroid opthalmopathy	9	57 ± 21	87 ± 10	30 ± 17
Fourth nerve palsy	7	61 ± 15	89 ± 9	28 ± 20
Third nerve palsy	6	71 ± 17	78 ± 19	7 ± 27
Restrictive strabismus	5	57 ± 19	82 ± 17	26 ± 31
Sixth nerve palsy	3	69 ± 13	95 ± 15	26 ± 31
Blowout fracture	2	72 ± 16	73 ± 11	1 ± 5
Others	2	91 ± 8	92 ± 9	1 ± 1
p-value		0.1942	0.7749	0.1612

SOP, Superior oblique muscle palsy. *$p < 0.05$, Kruskal-Wallis test.

largest and was comparable to the gain following cataract surgery. These findings indicate that the effect of diplopia complicating incomitant strabismus on QOL is greater than the effect of the impairment in binocular vision of comitant strabismus on QOL. The large gain following surgery for incomitant strabismus is considered to have been due to the resolution of diplopia, which negatively affects QOL [16, 17].

The mean pre- and postoperative VF-14 scores of cataract surgery were 62 and 84, respectively, and the mean surgical gain was 22. The preoperative VF-14 score in cataract patients has been reported to be 75.5 [10] or 64–76 [18]. Other studies reported that the score improved from 60.99 to 85.11 [19] and 69.1 to 79.4 [20] postoperatively. The results of our analysis support these reports. A strong correlation with visual acuity [2, 10] and the involvement of contrast sensitivity in the improvement in the score have been reported as characteristics of the VF-14 score in patients following cataract surgery [12]. The

Table 7 Preoperative and postoperative characteristics in strabismus group

	Comitant strabismus		Incomitant strabismus	
	Preoperative	Postoperative	Preoperative	Postoperative
Angle of strabismus in the primary position (deg), Mean±SD	21±10	3± 4	14± 9	4± 6
Percent decrease in ocular deviation (%), Mean±SD		83±24		74±36
BSG test, n (%)				
BSV	7 (14.6)	33 (68.8)	1 (2.1)	29 (59.2)
Diplopia	6 (12.5)	7 (14.5)	22 (45.8)	13 (26.5)
Suppression	35 (72.9)	8 (16.7)	25 (52.1)	7 (14.3)
Stereopsis, n (%)				
≦100sec of arc	17 (35.4)	24 (65.8)	19 (39.6)	28 (59.6)
120sec of arc≦	3 (6.3)	6 (14.0)	2 (4.2)	7 (14.9)
(−)	28 (58.3)	13 (30.2)	27 (56.2)	12 (25.5)
Diplopia, n (%)				
Never	17 (35.4)	21 (43.8)	5 (10.0)	26 (52.0)
Sometimes	12 (25.0)	21 (43.8)	5 (10.0)	17 (34.0)
Always	19 (39.6)	6 (12.4)	40 (80.0)	7 (14.0)

BSG, Bagolini striated glass; BSV, Binocular single vision.

Table 8 Multiple regression analysis with the gain of VF-14 score as dependent variable in strabismus group

	Partial correlation coefficient	*p*-value
Comitant strabismus		
Age	0.202	0.0329
Preoperative VF-14 score	−0.469	<0.0001
Type*	3.317	0.0235
Postoperative diplopia	−5.037	0.0167
Coefficient of determination (*p*-value)		0.679 (<0.0001)
Incomitant strabismus		
Preoperative VF-14 score	−0.687	<0.0001
Preoperative diplopia†	5.432	0.0290
Postoperative diplopia†	−12.025	<0.0001
Type**	5.470	0.0123
Postoperative ocular deviation	−2.13	0.0385
Coefficient of determination (*p*-value)		0.789 (<0.0001)

*Type of comitant strabismus: sensory exotropia, consecutive exotropia, or others, 1; exotropia, 2; intermittent exotropia, 3; esotropia, 4.
**Type of incomitant strabismus: Blowout fractures or others, 1; third nerve palsy, 2; decompensated superior oblique muscle palsy, 3; thyroid opthalmopathy, fourth nerve palsy, sixth nerve palsy or restrictive strabismus, 4.
†Diplopia: no, 0; sometimes, 1; always, 2.

marked gain is considered to have been achieved due to the effect on visual acuity. It may also be ascribed to the absence of other ophthalmic comorbidities, because their presence has been reported to impair QOL [10, 21] and reduce the gain [22].

In glaucoma patients, the preoperative mean VF-14 scores were 73 with glaucoma surgery alone and 74 with glaucoma combined with cataract surgery, which were the third highest next to those in comitant strabismus and ERM patients. This score for glaucoma patients has been reported not to differ from that of healthy individuals [23] and was 79.1 in a previous study [24], which is close to the 74 observed in the present study. The VF-14 score has been reported to

be significantly correlated with visual field loss in glaucoma [24–26]. However, the score has been reported to be higher than in age-related macular degeneration, which is associated with central visual field impairment [27], because the central visual field loss has a greater effect on QOL than does peripheral vision impairment [26]. The gain was smallest in glaucoma among the 6 diseases, but it was larger in glaucoma with cataract surgery than in glaucoma surgery alone. Cataract surgery is considered to achieve improved visual acuity, leading to an improvement in QOL.

The gain observed in DME was larger than that reported previously [28, 29]. Of the 6 diseases, the lowest preoperative VF-14 score was 57 in DME. The gain did not differ significantly compared with that of comitant strabismus, but it was significantly lower than that of incomitant strabismus. According to reports using VFQ-25, the preoperative score in DME was lower than that in glaucoma and cataract, and was comparable to that in age-related macular degeneration [28, 30], although the gain was smaller [28].

No effect of age or gender on the preoperative VF-14 score or its postoperative gain was noted, except in comitant strabismus and glaucoma. However, the gain increased with age in patients with comitant strabismus. This suggests that surgery is likely to improve the QOL even in elderly patients with comitant strabismus. In addition, the results of this study indicate that the type of strabismus affected the improvement in vision-related QOL.

This study had 2 limitations. First, the characteristics of the participants may have been biased because the study was limited to a single facility. Indications for surgery and the severity of target disorders may vary among facilities, and these factors may have affected the scores. Second, QOL may be evaluated differently between developing and developed countries and between urban and rural areas, owing to differences in social and economic circumstances [18]. With these limitations in mind, it is difficult to conclude definitively that the results of this study reflect the state of average patients.

Our study demonstrated that the surgical outcome for incomitant strabismus was comparable to that for cataract surgery, and was better than those for surgery for ERM, DME, glaucoma, and comitant strabismus. This clinical study was performed against the current social background in which the effects of medical services on society are assessed according to economic efficiency from the viewpoint of the effective use of medical resources, and the significance of the study is related to the fact that it clarifies the effects of surgical treatments for major ocular diseases on vision-related QOL.

Acknowledgments. Supported by the Grant-in-Aid (No. 22591964) and the aid from the Koyama Fund of the Relief Center for the Disabled and Patients with Refractory Diseases.

References

1. Massof RW and Rubin GS: Visual function assessment questionnaires. Surv Ophthalmol (2001) 45: 531–548.
2. Brown MM, Brown GC, Sharma S and Jennifer L: Health care economic analysis and value-based medicine. Surv Ophthalmol (2003) 48: 204–223.
3. van de Graaf ES, van der Sterre GW, Polling JR, van Kempen-du Saar H, Simonsz B and Simonz HJ: Amblyopia & strabismus questionnaire: design and initial validation. Strabismus (2004) 12: 181–193.
4. Hatt SR, Leske DA, Bradley EA, Cole SR and Holmes JM: Comparison of quality-of-life instruments in adults with strabismus. Am J Ophthalmol (2009) 148: 558–562.
5. Sabri K, Knapp CM, Thompson JR and Gottlob I: The VF-14 and psychologicl impact of amblyopia and strabismus. Invest Ophthalmol Vis Sci (2006) 47: 4386–4392.
6. Beauchamp CL, Beauchamp GR, Stager Sr DR, Brown MM, Brown GC and Felius J: The cost utility of strabismus surgery in adults. J AAPOS (2006) 10: 394–399.
7. Fujiike K and Yamada M: QOL Assessment and utility analysis. Jpn J Ophthalmic Surgery. (2010) 23: 426–429 (in Japanese).
8. Jackson S, Harrad RA, Morris M and Rumsey N: The psychosocial benefits of corrective surgery for adults with strabismus. Br J Ophthalmol (2006) 90: 883–888.
9. Burke JP, Leach CM and Davis H: Psychosocial implications of strabismus surgery in adults. J Pediatr Ophthalmol Strabismus (1997) 34: 159–164.
10. Steinberg EP, Tielsch JM, Schein OD, Javitt JC, Sharkey P, Cassard SD, Legro MW, Diener-West M, Bass EB, Damiano AM, Steinwachs DM and Sommer A: The VF-14 An index of functional impairment in patients with cataract. Arch Ophthalmol (1994) 112: 630–638.
11. Brown GC: Vision and quality-of-life. Trans Am Ophthalmol Soc (1999) 97: 473–511.
12. Datta S, Foss AJ, Grainge MJ, Gregson RM, Zaman A, Masud T, Osborn F and Harwood RH: The importance of acuity, stereopsis, and contrast sensitivity for health-related quality of life in elderly women with cataracts. Invest Ophthalmol Vis Sci (2008) 49: 1–6.
13. Fujita A, Hieda O, Nakajima N and Kinoshita S: The VF-14 index of functional visual impairment in patients with corneal disease treated by phototherapeutic keratectomy. J Jpn Ophthalmol Soc (2005) 109: 736–740 (in Japanese).
14. Bland JM and Altman DG: Statistical methods for assessing agreement between two methods of clinical measurement. Lancet

(1986) 1: 307–310.
15. Bland JM and Altman DG: Comparing methods of measurement: why plotting difference against standard methods is misleading. Lancet (1995) 346: 1085–1087.
16. Hatt SR, Leske DA, Kirgis PA, Bradley EA and Holmes JM: The effects of strabismus on quality of life in adults. Am J Ophthalmol (2007) 144: 643–647.
17. Hatt SR, Leske DA, Bradley EA, Cole SR and Holmes JM: Development of a quality- of-life questionnaire for adults with strabismus. Ophthalmology (2009) 116: 139–144.
18. Norregaard JC, Bernth-Petersen P, Alonso J, Dunn E, Black C, Andersen TF, Espallargues M, Bellan L and Anderson GF: Variation in indications for cataract surgery in the United States, Denmark, Canada, and Spain: results from the International Cataract Surgery Outcomes Study. Br J Ophthalmol (1998) 82: 1107–1111.
19. Bilbao A, Quitana JM, Escobar A, García S, Andradas E, Baré M, Elizalde B and IRYSS-Cataract Group: Responsiveness and clinically important differences for the VF-14 index, SF-36, and visual acuity in patients undergoing cataract surgery. Ophthalmology (2009) 116: 418–424.
20. Senba S: Cost-utility analysis of cataract surgery: measuring of the value of preference using time trade-off method. Tokyo University, Doctorate Thesis (Medicine) 1121220, (2009).
21. Yamada M, Mizuno Y, Miyake Y and Cataract Survey Group of the National Hospital Organization of Japan: A multicenter study on the health-related quality of life of cataract patients: baseline data. Jpn J Ophthalmol (2009) 53: 470–476.
22. Mozaffarieh M, Krepler K, Heinzl H, Sacu S and Wedrich A: Visual function, quality of life and patient satisfaction after ophthalmic surgery: A comparative study. Opthalmologica (2004) 218: 26–30.
23. Spaeth G, Walt J and Keener J: Evaluation of quality of life for patients with glaucoma. Am J Ophthalmol (2006) 141: 3–14.
24. Parrish RK, Gedde SJ, Scott IU, Feuer WJ, Schiffman JC, Mangione CM and Montenegro-Piniella A: Visual function and quality of life among patients with glaucoma. Arch Ophthalmol (1997) 115: 1447–1455.
25. Nah YS, Seong GJ and Kim CY: Visual function and quality of life in Korean patients with glaucoma. Korean J Ophthalmol (2002) 16: 70–74.
26. Mckean-Cowdin R, Wang Y, MS J Wu, Azen SP and Varma R: Los Angeles Latino Eye Study Group: Impact of visual field loss on health-related quality of life in glaucoma. The Los Angeles Latino Eye Study. Ophthalmology (2008) 115: 941–948.
27. Evans K, Law SK, Walt J, Buchholz P and Hansen J: The quality of life impact of peripheral versus central vision loss with a focus on glaucoma versus age-related macular degeneration. Clin Ophthalmol (2009) 3: 433–445.
28. Hariprasad SM, Mieler WF, Grassi M, Green JL, Jager RD and Miller L: Vision–related quality of life in patients with diabetic macular oedema. Br J Ophthalmol (2008) 92: 89–92.
29. Okamoto F, Okamoto Y, Fukuda S, Hiraoka T and Oshika T: Vision-related quality of life and visual function after vitrectomy for various vitreoretinal disorders. Invest Ophthalmol Vis Sci (2010) 51: 744–751.
30. Okamoto F, Okamoto Y, Fukuda S, Hiraoka T and Oshika T: Vision-related quality of life and visual function following vitrectomy for proliferative diabetic retinopathy. Am J Ophthalmol (2008) 145: 1031–1036.