EXTENDED REPORT

Visual function and car driving: longitudinal results 5 years after cataract surgery in a population

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Aims: To determine visual function in drivers who had cataract surgery 5 years previously, and to analyse longitudinal data, by comparing preoperative and postoperative changes in subjective driving ability and objective visual function.

Methods: All patients (810) who underwent cataract surgery, during a 1 year period, were prospectively studied. Data regarding present driving status were collected from self administered questionnaires and visual acuity (VA) data were measured before and after surgery. All patients who were alive 5 years later were invited to participate with a new eye examination and questionnaire.

Results: Before surgery 36 active drivers (16%) did not fulfil the visual requirements for driving; with improved glasses this number could be reduced to 24 (11%). 5 years after surgery, the corresponding figures were 5% and 3% (5/174), respectively. Before surgery 50% stated visual difficulties while driving in daylight and 79% in darkness. A few months and 5 years after surgery the corresponding figures were 6% and 5%, respectively, for daytime driving and 34% and 44%, respectively, for night-time driving.

Conclusions: Long term results regarding cataract surgery in car drivers are beneficial. 5 years after surgery only a few patients drove not fulfilling the requirements, but there were a larger proportion of patients with problems driving in darkness compared with a few months after surgery.

Previous research has found the occurrence of cataract was significantly associated with difficulties in driving.[1] Cataract patients were more likely to report difficulties in challenging driving situations, and more often experienced a restriction in their driving ability, and a decrease in their safety on the road. Drivers with cataract were 2.5 times more likely to have a history of at-fault crash involvement in the previous 5 years adjusted for miles driven/week and days driven/week.

In an earlier publication we reported that subjective and objective visual function in drivers was substantially improved after cataract surgery.[2] Moreover, it was not uncommon for drivers with cataract to drive with vision not fulfilling the visual requirements before surgery. To the authors' knowledge, no long time results of cataract surgery outcome in drivers have yet been published.

MATERIALS AND METHODS

Study population

All patients who underwent cataract surgery, between 1 June 1997 and 31 May 1998, at Norrlands University Hospital in Umeå, Sweden, were prospectively registered. All cataract surgery of the population was performed at the university clinic, as there are no other public or private operating eye clinics in the area. The admitting area has a population of about 180 000 people and is sparsely populated with only 3.8 inhabitants per square kilometre. The means of public transportation are few and the population must to a large extent rely on car driving.

Inclusion and exclusion criteria in 1997–8, and response rate

In all, 928 cases of cataract surgery were registered during the 1 year period. Patients who underwent cataract surgery for other reasons than restoring vision, or had cataract surgery combined with other types of ocular surgery, were excluded. Also excluded were patients with dementia making them unable to cooperate with a questionnaire. The study included a total of 810 senile and presenile cataract patients.

The response rate for all patients including dead patients was 94%. No significant differences in sex were found between the dropouts and those included, but the dropouts were significantly older than the study patients (mean age 78.7 years versus 74.6, $p<0.0001$). The frequency of cataract surgery for the time period studied was 5.2 per 1000 population.

Preoperative and postoperative data

The following data were recorded; age, sex, first or second eye surgery, presenting and best corrected monocular visual acuity (VA) of both eyes before and after surgery (Monoyer Granström letter chart), type of surgery and complications, and ocular co-morbidity.

Age related macular degeneration (AMD) was defined as pigment changes or drusen in the macular area only in conjunction with a VA of 20/30 or worse after surgery.[3]

Data collected 5 years after surgery

Five years after surgery, we checked with the Swedish Population Register which patients were still alive; 220 patients were dead (220/810; 27%). All survivors were asked to participate with the same questionnaire, and a new eye examination. Forty seven patients could not participate because of dementia, seven could not be located, and six refused. Five hundred and thirty patients participated with the questionnaire—that is, 99% of the eligible sample (530/536), and 90% of survivors (530/590). In addition to the questionnaire 467 patients also underwent an eye examination, making up 79% of survivors (467/590). The major reason for not participating with the eye examination was trouble/unwillingness to travel to the eye clinic, either because of illness or long distance.

Abbreviations: AMD, age related macular degeneration; BCVA, best corrected visual acuity; VA, visual acuity

Table 1 The questions analysed in the study

Questionnaire I
Before cataract surgery
1 Do you have a valid driving licence?
(a) No, never have had
(b) No, but I have had one earlier. Go to question 5
(c) Yes. Go to question 2
2 Do you currently drive a car?
(a) Yes. Go to question 3
(b) No. Go to question 5
3 How much difficulty do you have driving during the day because of your vision?
Do you have
(a) No difficulty
(b) A little difficulty
(c) A moderate amount of difficulty
(d) A great deal of difficulty
4 How much difficulty do you have driving at night because of your vision?
Do you have
(a) No difficulty
(b) A little difficulty
(c) A moderate amount of difficulty
(d) A great deal of difficulty
(e) Do not drive because of vision
5 When did you cease driving?
(a) Less than 6 months ago
(b) 6–12 months ago
(c) More than 12 months ago
6 Why did you stop driving?
(a) Vision too bad
(b) Other illness
(c) Other reason
Questonnaire II
After cataract surgery
Questions 2, 3, and 4 from questionnaire I were used
Questionnaire III
5 years after cataract surgery
Questions 1–6 from questionnaire I were used

The eye examination was performed in the same manner as in 1997–8, with the exception that an EDTRS VA chart was used. Patients with failure to read any letters were tested using counting fingers (CF), hand movements (HM), and light perception (LP), and scored as outlined in earlier publications.[4 5]

Questionnaires

One to 2 weeks before surgery a self administered questionnaire was mailed to the patients. On the day of surgery, the questionnaire was delivered by the patient to the clinic. We checked that the questions had been understood and completely answered. Approximately 1 month after the patients had received their prescription spectacles (if required) a second questionnaire was mailed to them. Five years after surgery a similar questionnaire was mailed to all surviving patients who were able to participate. Those who had an eye examination delivered the questionnaire to the clinic, and those who did not participate with an examination mailed the questionnaire to the research team.

The questionnaires contained the questions used by Steinberg *et al*[5] in their questionnaire (VF-14), and a few additional questions used in our previous study.[2] The VF-14 is extensively validated and has been found to have high reliability, responsiveness, and validity.[5–7] The questions analysed in the present study are presented in table 1.

Requirements for driving

As Sweden is a member of the European Union (EU), the minimal legal requirements for non-commercial car driving (fitness to drive) is a binocular best corrected VA (BCVA) of 20/40 or better. Drivers with only one functional eye must have a minimum acuity of 20/33.[8]

Statistical methods

Two sample *t* tests were used to compare differences in age between patients with and without a driving licence. Yates's corrected χ^2 test or Fisher's exact tests were used to analyse the 2×2 frequency tables. All tests were two sided and p values <0.05 were considered statistically significant. Analyses were performed by means of the SPSS software 11.5.

RESULTS

Demographic and VA data, in relation to holding a driving licence

Figure 1 shows a flow chart of the driving status before and after surgery, and 5 years later of the patients operated during the 1 year period (1997–98).

Before surgery 407 (50%) patients had a valid driving licence, 50 (6%) had had a licence earlier in life, and 353 (46%) had never had a licence.

The mean age of those with driving licences was significantly lower (70.7 years (SD 11)) than those without licences (78.7 years (SD 8.8); $p<0.0001$), table 2. Fifty six per cent of those with driving licences were men (226/407), 86% (346/403) of those without licences were women (table 2).

Patients without driving licences had significantly worse VA of the eye to be operated and the better eye, both before and after surgery. Before surgery, 32% of the patients with driving licences did not fulfil the visual requirements for driving before surgery. A new refraction and a change to optimal glasses would only reduce this figure to 25%. After surgery, only 5% of those with driving licences did not fulfil the visual requirements.

Relation between driving status and fulfilment of VA requirements for driving

Before surgery, 55% (224/407) of the patients with a driving licence were active drivers, 66% of these were men (fig 1).

Before surgery 36 active drivers (16%; 36/224) did not fulfil the visual requirements for driving. With improved glasses this number could be reduced to 24 (11%) (table 3). Figure 2 shows the distribution of VA of the better eye of these drivers.

Those who drove without fulfilling the legal requirements before surgery were significantly older (74.4 years versus 67.2 years, $p<0.00001$).

After surgery 285 patients were drivers (fig 1). There were only two patients (2/285; 1%,) who drove without fulfilling the visual requirements for driving. Both of them had a VA just below the limit. Both of these two patients did not drive 5 years later.

Five years after surgery 189 patients were active drivers, 63% of the eligible patients with driving licence (fig 1). VA data were available from 174 drivers, as 15 did only participate with the questionnaire. Nine patients (5%) did not fulfil the legal VA requirements with the worst VA of 20/83. With improved spectacles five patients (3%) remained below the limit, most of them by only a few letters.

Those who did not fulfil the legal requirements were significantly older (69.6 *v* 78.2 years; $p<0.0001$). There were also an increased percentage of males (7% *v* 3%; $p = 0.32$), and patients with only the first eye operated (57% *v* 30%; $p = 0.13$), but these differences were not statistically significant.

Six patients of the nine (67%) who did not fulfil the legal requirements had a diagnosis of ARM before surgery, versus 11% of those who had sufficient VA ($p<0.0005$). Five years after surgery eight of nine patients (89%) with too low VA had ARM, and the remaining patient had glaucoma as major diagnosis for reduced VA.

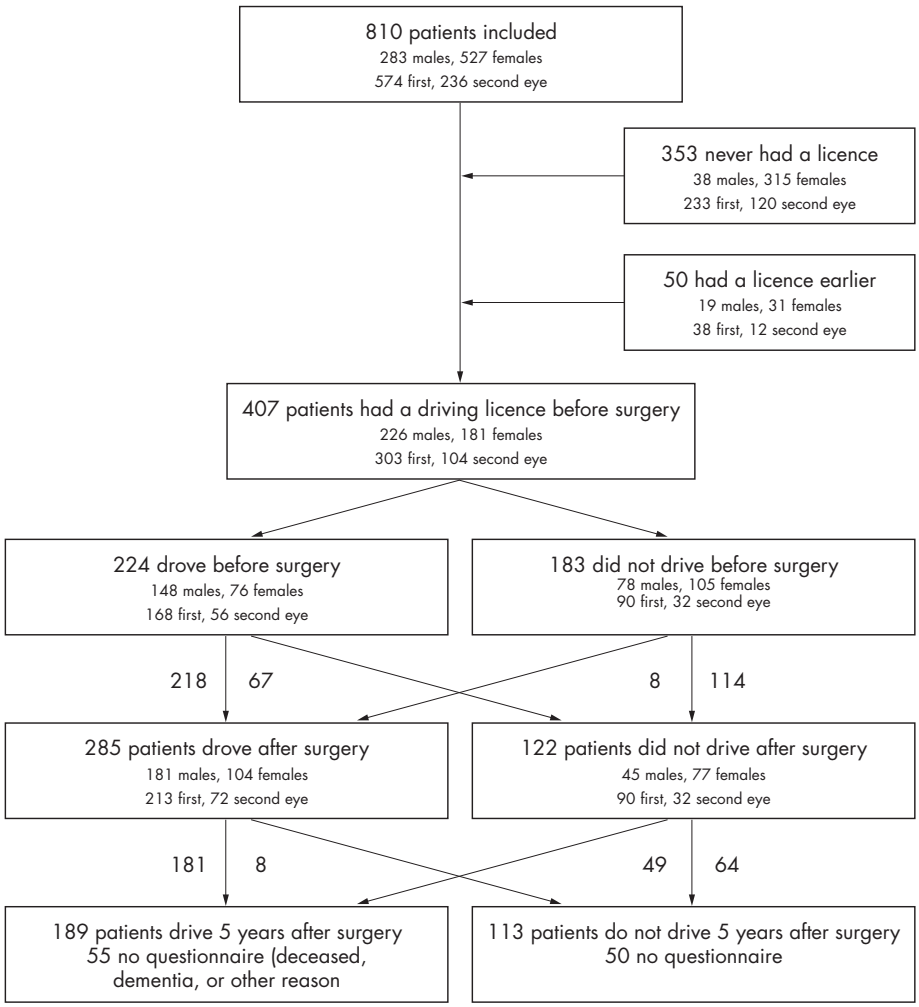

Figure 1 Flow chart of the driving status before and after surgery, and 5 years later.

Change in driving status after surgery, and 5 years later

Sixty seven patients (67/183;37%) who did not drive before surgery started to drive after surgery. Before surgery, 46% (31/67) and 35% (24/67) of these did not fulfil the visual requirements for driving regarding presenting and best corrected VA of the better eye, respectively. After surgery all of these active drivers had sufficient VA to drive legally. Five years after surgery, 82% (40/50) of those patients who started to drive after surgery, and participated with the questionnaire were still active drivers.

Non-drivers 5 years after surgery

Five years after surgery there were 132 patients who did not drive, but who still had or have had a licence earlier in life. This group consists both of the 113 non-drivers after 5 years

Table 2 Demographic variables and VA data for all patients operated in 1997–8

	Driving licence	No driving licence	p Value
No of patients	407	403	
Mean age (years) (SD)	70.8 (11.0)	78.7 (8.8)	**<0.0001***
Age range (years)	36–91	30–96	
Males (%)	56	14	**<0.0001****
First eye surgery (%)	74	67	**0.024****
Presenting visual acuity 20/200 or less of the eye to be operated (%)	48	60	**0.0009****
Best corrected VA 20/200 or less of the eye to be operated (%)	44	56	**0.0016****
Presenting visual acuity less than 20/40 of the better eye before surgery (%)	32	52	**<0.0000****
Best corrected VA less than 20/40 of the better eye before surgery (%)	25	48	**<0.0000****
Best corrected VA 20/40 or less of the operated eye after surgery (%)	10	23	**<0.0000****
Best corrected VA 20/40 or less of the better eye after surgery (%)	5	18	**<0.0000****

*Two sample, two tailed *t* test, **χ^2 test.

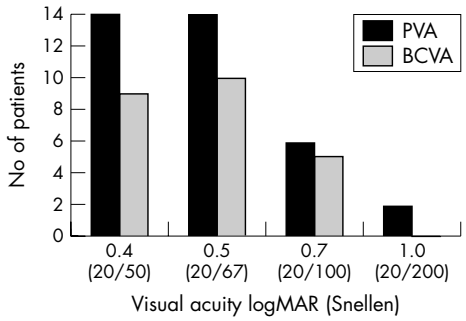

Figure 2 Distribution of presenting (PVA) and best corrected visual acuities (BCVA) of the better eyes, in patients driving but not fulfilling the visual requirements, before cataract surgery.

and the 19 surviving patients from the group of 50 who were ex-drivers already before surgery (fig 1). Table 4 shows the reasons stated for not driving. Most of those who thought their vision was too bad (65%) did not fulfil the visual requirements. Surprisingly few did not drive because of health problems other than ocular co-morbidity (26/132; 20%).

Subjective visual problems while driving before and after surgery, and after 5 years

Before surgery 50% (110/222) of the patients reported visual difficulties with daytime driving (table 3). After surgery this figure had decreased to 6% (17/281). Regarding driving in darkness, 69% (150/217) reported visual difficulties before surgery, 21% (46/217) had no visual problems, and 10% (21/217) never drove in darkness. After surgery, 24% patients had visual difficulties when driving in darkness (67/281), and 28 (10%) never drove in darkness.

Five years after cataract surgery 95% (179/188) of the patients reported no visual difficulties during daytime driving. The corresponding figure for night driving was 56% (105/188).Twenty two patients (12%) had visual difficulties to such a large degree they never drove during the night (table 3). There was a statistically significant larger percentage of patients with visual difficulties while driving at night ($p<0.05$) 5 years after surgery compared with a few months after surgery.

DISCUSSION

Onset of cataract and its surgery have both legal and practical consequences for driving. The data presented might be compared with a similar study by us from 1992.[2] The frequency of cataract surgery in 1997–8 was considerably higher than in 1992 (5.2 *v* 3.3 per 1000 population, respectively).

We found that 11% of the patients who drove before surgery had a BCVA of less than 20/40, and the corresponding figure from 1992 was 23%. Increased frequency of surgery reduces the proportion of patients who drive preoperatively with a VA below the requirements. This finding coincides with previous research that increasing frequency of cataract surgery will result in better VA of both eyes before surgery.[9 10]

We found that half of those who were active drivers before surgery had subjective visual problems while driving in daylight, and 69% while driving in darkness. After surgery these figures had been reduced to 6% and 24% (table 3).

A few months and 5 years after surgery, the frequency of subjective visual difficulties while driving in daylight was low. However, there was a significantly larger proportion of drivers with visual difficulties during night-time 5 years after surgery, although median VA was unchanged. The reason for this is unknown. Further investigation of this finding and the implications for crash incidence is clearly warranted.

The proportion of patients with a driving licence before surgery increased from 46% to 50%, between 1992 and 1997–8, although mean age was unchanged. Patients without a licence were mostly elderly women (86%), who by tradition have never learnt to drive. In the age group 67–79 years, 91% of males and 58% of females in Sweden have a valid licence. In 1991 the proportion of people aged 80+ with driving licence was 29%, and in 2002, 51%.[11] In the industrialised society the number of elderly people is increasing because of longer lifespan. This fact, together with the escalating proportion of elderly women having a driving licence, and the higher incidence of cataract in women,[12 13] might account for a substantial number of cataract patients with a driving licence in the future.

Five years after surgery, 63% of the eligible patients with a driving licence were active drivers. In this group nine patients (5%), did not fulfil the VA requirements. Starting in 1999, there is in Sweden an obligation for lorry and bus drivers older than 45 years of age to have a medical check up including VA to maintain a licence for these vehicles. This check up must be repeated every 10 years. At present there is no obligation for non-commercial car drivers to have their acuities checked, although this matter has been discussed.

In conclusion, before surgery subjective visual problems while driving were found in a large proportion of cataract patients and a substantial number of patients drove without fulfilling the visual requirements. Drivers with significant cataract, visual functional difficulties, and/or reduced VA

Table 3 Visual function of drivers before and after surgery and 5 years after surgery

	Before surgery	After surgery	5 years after
No of actual drivers	224	285	189
Mean age (years) (SD)	68.3 (11.3)	68.9 (11.9)	70.3 (11)
Age range (years)	36–89	36–88	35–91
Males	66%	64%	62%
One eye operated for cataract	25% (56/224)	70% (199/285)	33% (62/189)
Both eyes had cataract surgery	–	30% (86/285)	67% (127/189)
Presenting visual acuity less than 20/40 of the better eye	16% (36/224)	1% (2/285)	5% (9/174)*
Best corrected VA less than 20/40 of the better eye	11% (24/224)	1% (2/285)	3% (5/174)*
Median log MAR (Snellen) PVA and BCVA of the better seeing eye	0.097 (20/25)	0 (20/20)	0 (20/20)
Visual difficulties, daytime driving†	50% (110/222)	6% (17/281)	5% (9/188)
Visual difficulties, night-time driving	69% (150/217)	24% (67/281)	32% (61/188)
Do not drive in darkness†	10% (21/217)	10% (28/281)	12% (22/188)

*VA data are based on 174 drivers as 15 of 189 participated with questionnaire only.
†A few answers are missing in each group, therefore the sums in the denominators do not equal the total number.

Table 4 Reasons stated for not driving

	No of patients (with VA data)	Males	Do not fulfil the legal VA requirements	VA ⩾20/25 in the best eye
		No (%)	No (%)	No (%)
Thinks vision too bad	41 (40)	17/41 (41)	26/40 (65)	7/40 (18)
Good vision but insufficient health	26 (20)	14/26 (54)	1/20 (5)	9/20 (45)
Uninterested, no need for a car	38 (36)	6/38 (16)	0/36	26/36 (72)
Healthy eyes and body but feels too old	17 (14)	4/17 (24)	1/14 (7)	7/14 (50)
No licence because of traffic violation	2 (2)	2/2 (100)	0/2	2/2 (100)
No answer	8 (4)	1/8 (12)	1/4 (25)	3/4 (75)
Total	132 (116)	44/132 (33)	29/116 (25)	54/116 (47)

should be prioritised for cataract surgery.[14 15] Five years after surgery only a few patients drove not fulfilling the requirements, but there were a larger proportion of patients with problems driving in darkness compared with a few months after surgery. The long term impact of cataract surgery in car drivers is beneficial.

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