Stæren er almindelig udbredt.
Den er indført til U.S.A. og Australien, og især er den det første sted blevet en ulidelig plage.

(Ingvald Lieberkind, Fugle III.)

This thesis is based on the following papers, which will be referred to in the text by their roman numerals

I. Ninn-Pedersen K, Stenevi U, Ehinger B.: Cataract Patients in a defined Swedish population 1986-1990. I. Resources and epidemiology. Acta Ophthalmol (Copenh). 1994;72:1-9.

II. Ninn-Pedersen K, Stenevi U, Ehinger B.: Cataract patients in a defined Swedish population 1986-1990. II. Preoperative observations. Acta Ophthalmol (Copenh). 1994;72:10-15.

III. Ninn-Pedersen, K.: Relationships between preoperative astigmatism and corneal optical power, axial length, intraocular pressure, gender, and patient age. Journal of Refractive and Corneal Surgery. 1996;12: 472-482.

IV. Ninn-Pedersen, K. and Stenevi, U.: Cataract patients in a defined Swedish population 1986-1990. lV. Observations and complications at surgery. Submitted to Journal of Cataract and Refractive Surgery 1996.

V. Ninn-Pedersen, K. and Bauer, B.: Cataract patients in a defined Swedish population 1986-1990. V. Postoperative retinal detachments. Archives of Ophthalmol. 1996;114: 382-386.

VI. Ninn-Pedersen, K. and Bauer, B.: Cataract patients in a defined Swedish population 1986-1990. Vl. YAG laser capsulotomies in relation to preoperative and surgical conditions. Submitted to Acta Ophthalmol (Copenh) 1996.

VII. Ninn-Pedersen, K. and Stenevi, U.: Cataract patients in a defined Swedish population 1986-1990. VII. Inpatient and outpatient standardized mortality ratios. British Journal of Ophthalmology. 1995;79: 1115-1119.

VIII. Ninn-Pedersen, K.: Cataract patients in a defined Swedish population 1986-1990. VIII. Postoperative astigmatism, intraocular pressure and visual acuity. Submitted to Acta Ophthalmol (Copenh) 1996.

CONTENTS

1. INTRODUCTION

Cataract is the main cause of blindness. Globally, at least 17 million people are blind because of it. In comparison, 6 million are estimated to be blind because of infections like trachoma, onchocerciasis and different types of keratitis (Foster & Johnson 1993). A patient suffering from cataract has a cloudy lens, and the purpose of cataract extraction is to remove the visual acuity impairment caused by the lens. Dilatation of the pupil, changing spectacle lenses, use of magnification or appropriate illumination are important non-surgical treatment tools. Such visual aids may be acceptable for many cataract patients without access to surgery, but are often not effective enough.

In modern times, all cataract surgery in Sweden has been registered since 1980 (Stenevi 1987, Ninn-Pedersen et al. 1994a). The number of cataract operations has increased tremendously since 1980, starting at 8 000 operations in 1980 and reaching 41 009 in 1995. This means that about 4.7 ‰ of the Swedish population was operated on because of cataract in 1994. This is equivalent to saying that approximately every fourth person in Sweden will eventually undergo cataract surgery if the situation in 1995 prevails. It is apparent that a procedure of such dimensions has a large impact on many aspects of society. Therefore, it should be monitored closely in order have it optimised. The number of operations per 1000 inhabitants in other European countries are likely to be lower (1.8 in the UK in 1992, 2.8 in Denmark in 1990, 2.7 in Norway in 1990); but higher in the USA 5.4 in 1992 (Ninn-Pedersen et al. 1994a; Courtney 1992; Stenevi et al. 1995; Stenevi, personal communication 1996).

The increase in the cataract surgery in Sweden is striking, even in comparison with other European countries, including the Nordic region. There are no studies that explain the differences between the countries. However, likely reasons include improved surgical procedures and interest in the issue by Swedish politicians and the press. Further, there have been a series of conferences and reports sponsored by among others the Medical Research Council and the Swedish National Board of Health (SPRI 1984; Ehinger et al. 1991; Lundström et al 1995).

2. AIMS OF THE STUDY

At the Department of Ophthalmology in Lund, Sweden, a large number of parameters are routinely registered before under and after cataract surgery on all patients referred for surgery. The Lund Health Care District serviced 382 811 inhabitants in 1990, and with only insignificant exceptions, all cataract patients in this population were referred to Lund. All patients operated on because of cataract in the referral region of the Lund Health Care District during the years 1986 to 1990 were included. The total number of operations monitored was 5878.

Because all cataract surgery in the region and not only surgery on a selected group of patients were performed in Lund it is possible to show pertinent figures on refraction before and after surgery as well as complications occurring under and after the operation.

The well-defined population and the large amount of information in our database gives us the possibility to evaluate not only the surgery and the visual acuity outcome, but also epidemiological figures such as sex differences, operating ratio and survival figures for cataract patients. Further, the comprehensive Swedish census system provides detailed and precise information about the average death rates and the death diagnoses, highly useful in this kind of research.

3. MATERIALS AND METHODS

The Lund Health Care district has a single facility offering ophthalmological care, the Department of Ophthalmology of the Lund University Hospital. The outpatient service handles about 31 000 patient visits per year, and the surgical facilities (1992) handled about 1400 cataract operations per year at the end of this study. Surgery was not performed at any other clinic in the District. During the period reported here (1986-1990), surrounding health care districts belonging to the Malmöhus County Council had outpatient clinics, but none of them had any facilities for cataract surgery, and all of them sent their patients to Lund for cataract surgery, except the Landskrona Health Care District (49179 inhabitants in 1990), which sent about 2/3 of their cataract patients to Lund. Corrections have been made for this. The referral rate did not change during the period studied. Only under exceptional circumstances could the surrounding health care districts send a patient anywhere else than to Lund for cataract surgery. The total population serviced by the Lund University Eye Clinic with cataract surgery thereby comprised 364,679 inhabitants in 1986, which increased to 382,811 in 1990.

The age distribution of the population which the Lund cataract surgery patients came from did not change in any important way during the period studied, nor did the age distribution in Sweden. However, the younger age groups dominated somewhat in the Lund cataract referral region.

The data collected for analysis comprises 5878 consecutive cases operated on from 1986 through 1990. All operations were performed at the Department of Ophthalmology at the University of Lund. Patients under 15 years of age were not included. The actual number of patients analysed in different parts of the study is often somewhat smaller, depending on varying patient inclusion criteria used in the different analyses. This is documented in the papers describing the details of the analyses.

The 'Cataract Analysis System (CAS™)' of dr. Thomas V. Cravy (St. Maria, Calif.) was used for collecting, storing and retrieving the surgery data. Two CAS forms were attached to the patient's file. The first form concerned preoperative and surgical data, and in the second, the postoperative development was recorded. The first form was filled in at the Department of Ophthalmology in Lund. The second was used by the physicians monitoring the postoperative development of the patient. When the patient was referred back to his home clinic, copies of the forms followed the patient. The clinic at Lund

received a copy of the postoperative development form from the patient's home clinic at least when glasses were prescribed three to four month after the operation. Reminders were distributed to the participating clinics when follow-up forms were missing for a patient. A total of about 40 ophthalmologists were involved in collecting the data.

The intention was to follow the patient at least until new glasses were prescribed. In cases of postoperative complications such as capsular haze needing YAG laser treatment, long-standing uveitis, intraocular bleeding, or retinal detachment, the follow-up period could be much longer.

The following measurements were obtained on the standard pre-printed CAS forms.

3.1. Data obtained immediately before surgery

The following parameters were scored:

Uncorrected visual acuity;
axial length;
calculated IOL power;
age;
right or left eye;
intraocular pressure;
keratometer readings (absolute diopter readings at two perpendicular axes);
planned refraction;
sex;

A short ocular history with standardised questions was also recorded:

history of:
diabetes?
macular degeneration?
retinal detachment?
amblyopia?
glaucoma?
iritis?
rheumatoid arthritis?
collagen vascular disease?

If diabetes:
insulin needed?
background retinopathy?
proliferative retinopathy?

if glaucoma:
on timolol?
on pilocarpine?
on epinephrine?
on carbanhydrase inhibitor?
on phospholine iodide?

The preoperative measurements were obtained 2-10 days before surgery. Measurements taken on the eye which was not to be operated on were not entered in the data base.

3.2. Data obtained at surgery time

Name of the surgeon and the referring clinic.
In- or outpatient surgery?
Mode of extraction and type of intraocular lens.
Type of and extent of incision.
Type of wound closure.
Iridectomy?
Radial sphincterotomy?
Posterior capsulotomy?
Torn zonules or torn capsule?
Vitreous loss?
Vitrectomy?
Hyphema?
Lens implantation aborted?
Healon used?
Hyaluronidase used?

Operative keratometry was also performed, but not as a routine.

3.3. Data obtained after the surgery

At every visit:
uncorrected and/or corrected visual acuity;
keratometer readings (absolute diopter readings at two perpendicular axes);
intraocular pressure;
refraction;

Different postoperative complications and developments were noted:
Sutures removed?
Posterior capsular opacity?
Laser capsulotomy?
Cystoid macular oedema?
Macular degeneration?
Subluxation of implanted lens?
Glaucoma?
Optic neuropathy?
Choroidal detachment?
Retinal detachment?
Wound dehiscence?
Reoperation required?
Iritis?
Vitritis?
Uveitis/Glaucoma/Hemorrhage syndrome?
Diabetes?

If postoperative glaucoma:
On timolol?
On epinephrine?
On pilocarpine?
On phospholine iodide?
On diamox?
Laser trabeculoplasty?
Glaucoma surgery?

In cases where complications occurred such that surgical interventions were needed, the patients were always referred back to the Department of Ophthalmology at the University of Lund. Thus, all complications requiring surgery have been entered into the database, except if the patient had moved from the region, a rare occurrence in this age group. The yearly moving rate is below 0.5% for residents older than 65 years.

Despite the relative standardisation of the cataract surgery, some major changes have been implemented during the period studied. They include a gradual switch to outpatient cataract surgery and an increase in the number of operations performed. Both these factors will be dealt with. There have also been some variations in the lens extraction procedure (paper V and VI).

Throughout the study, the standard surgical procedure was a planned extracapsular cataract extraction, using an automated irrigation/aspiration device. About 83 per cent (4450 of 5350) of the intraocular lens implants were of a three piece polymethyl methacrylate (PMMA) type with closed prolene haptics lying in a plane parallel to the main plane of the lens (style 30, 3M). The implants were generally placed in the capsule bag. The alternatives that have been used have been reported separately (paper VI).

The study did not cause any added discomfort for the patients. Except for a few keratometry measurements soon

after surgery, it did not involve any tests or visits in addition to the ones needed for the proper follow-up of the patients.

3.4. Missing data and the number of eyes

The forms with preoperative data were compared with the official records kept at the department. The data forms were missing in about 4% of all cases which therefore could not be included in this study. In addition, single entries were also missing in about 5-9%. To make the database as complete as possible it has been continuously validated, corrected and improved in the course of the study. The figures on the size of the patient cohort presented in different parts of the study therefore vary slightly. In the first papers, we had access only to the number of operations, not the number of patients operated on, which is a lower figure, because some patients were operated on both eyes. Such figures have later become available. An overview of the differences in the different papers is given here.

5878 eyes in 5120 patients were operated on because of cataract. Six operations were performed in patients without a social security number. 238 operations were performed in patients from different or undefined health care districts. Postoperative data are not available on these. The remaining 5634 eyes in 4916 patients included 914 operations on the second eye, and these patients had their first eye operated before this study was started. Of the 4916 patients 718 had cataract surgery in both eyes under the study period. In 4002 patients in the study, it was the first eye that was operated on.

4. RESEARCH DESIGN AND STATISTICS

This study can be classified as an observational study. The researchers collected information on the measurements of interest, but did not influence the events. The data was collected prospectively (forward in time) except in the retinal detachment and in the YAG laser studies in which the prospectively collected data figures were double checked with data from the detachment surgery registry and the YAG laser treatment registry.

The study was in many ways cross-sectional with individuals observed only once. Especially the parts concerning preoperative data and observations at surgery were constructed in this way. Longitudinal studies are those which investigate changes over time on more than one occasion on each individual. Many of the postoperative studies such as the postoperative astigmatism analysis and the investigation of the postoperative visual acuity were designed in this way. The pseudo-longitudinal study in which each subject is seen at only one time, but the data are used to describe changes over time was used when the relationship between the axial length of the eye and patient age at operation were examined (Altman 1995).

Data were originally recorded and analysed in the CAS™ system. Later, the information was transferred to the SPSS "Statistical Package for The Social Sciences" for Windows. Statistical advice has been obtained from the Department of Statistics at the University of Lund, Sweden. Standard procedures were used for obtaining averages, standard deviations, standard errors of the mean and regressions. Comparisons between categoric variables were made with the χ^2 test. In cases when one or both of independent samples could not be regarded as normally distributed (for instance median age or axial length in the small detachment group and the large non-detachment group), differences were tested with the non-parametric Mann-Whitney U-test. The non-parametric Kruskal-Wallis´ test for more than two independent samples was used to find distribution changes within groups. Another non-parametric test, Bartholomew's proportional test for trends, was used to check if there was an increase in the proportion of women over the years, 1986-1990.

Primary death diagnoses and death figures of the cataract patient were obtained from the Swedish Bureau of Census. The register covers the whole country so all deaths were registered. Kaplan Meier graphs and Cox's proportional hazards model could be used for the statistical analyses. Standardised mortality ratios (SMR) were calculated when the survival figures from the cataract operated patients were compared with the survival figures and the primary death diagnoses from the whole population in the referral region, about 380 000 inhabitants.

5. RESULTS

If nothing else is stated, only observations with a statistical significance of $p < 0.05$ have been included in this summary of the study.

5.1. Demography and epidemiology (I, VII)

5.1.1. Resources and epidemiology

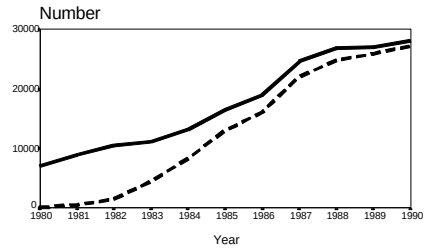

Fig. 1. Number of cataract operations per year in Sweden 1980 - 1990. Solid line: Total number of cataract extraction's performed yearly. Dashed line: Total number of intraocular lens implantation's.

The nation-wide survey shows that as a result of increasing demand for surgery, the number of cataract extraction's per year in Sweden has increased from 1980 to 1990 (Fig. 1). The percentage of eyes receiving an intraocular lens implant increased from near zero to over 95%.

In Lund, the cataract extraction's increased rapidly per inhabitant from 1.7 per thousand in 1986 to 3.6 per thousand in 1990. Nation-wide, the annual incidence was in 1986 somewhat higher than in Lund, but the subsequent rise has been slower, so that the Lund figures in 1990 were slightly above the nation-wide ones. Outpatient cataract surgery has increased dramatically during the period of study; in round numbers from 30% to 60%. Operations on the second eye were relatively rare in 1986, about 4.5 per cent of all operations, but increased sharply in 1988 to about

18%. Nationally, the figure had risen to 28% in 1992 (Stenevi et al. 1995).

In the higher ages, females progressively dominate. The preponderance of women is to some extent due to the fact that they live longer than males, but also when correcting for this (fig. 2), the difference remains, albeit diminished. The overall male to female ratio rose from 61 per cent in 1986 to 64 per cent in 1987, but there was no significant difference in the sex ratio over the following years (Bartholomews' test)

There were only minor changes in the mean age at surgery during the period of study. The figures are very similar to the average age at surgery seen in an urban population in Denmark 1947-1970 (Brændstrup 1977).

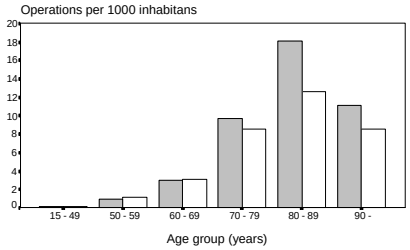

Fig. 2. Relative incidence of cataract operations in different age groups in 1986 in Lund. Filled columns, women; open columns, men. Total number of eyes: 594.

5.1.2. Mortality and cataract

The standardised mortality ratio (SMR) represents the observed number of deaths divided by the expected number. The standardised mortality among inpatients was increased in both young women and young men (young is here defined as less than or equal to 74 years old). In contrast, inpatients above or equal to 75 years old did not show any such increase. Among outpatients, the young patients did not have any increased standardised mortality. On the other hand, the elderly (75 years and above) showed a significant decrease in their standardised mortality ratio.

There was in all groups roughly a doubling of the standardised mortality ratio in patients with diabetes. In older diabetic outpatients, there was an approximately normal standardised mortality ratio, but this was worse than in older non-diabetic outpatients, which have a decreased standardised mortality ratio.

Cardiovascular disease is one of the most common mortality causes. In patients with such disease as their primary death diagnosis, there was a slight increase in the standardised mortality ratio in young inpatients operated for cataract. In outpatients, older women with cardiovascular disease as their primary death diagnosis had a lowered standardised mortality ratio.

Patients with diabetes at the time of surgery and which later died from a blood circulation disease showed increased standardised mortality ratios in most groups, but the increase was similar to that seen in all diabetic patients.

We considered the influence of a number of different variables on mortality. Besides age, five of them reached significance. They were gender, diabetes, preoperative rheumatoid arthritis, preoperative intraocular pressure and whether or not the patient had a YAG-capsulotomy postoperatively. Increased mortality risks were found for men (1.57), diabetic patients (2.02), and rheumatoid patients (2.75).

A subsequent analysis of the covariates showed that besides the findings described above, the preoperative presence of age-related macular degeneration was correlated with a significant increase of the mortality by about 25% (Ninn-Pedersen, unpublished).

5.2. Preoperative observations (II, III)

5.2.1. Preoperative observations

The almost twofold increase in the incidence of cataract surgery from 1986 to 1990 has been accompanied by an improvement in the visual acuity in the same period of time. The visual acuity tended to be lower in males than in females. Patients operated on their second eye showed the same development and the same overall distribution of their visual acuities.

Women tended to have a slightly higher intraocular pressure (16.4 mm Hg) than men (16.0 mm Hg) in cases not known to have glaucoma.

Women eyes on the average are 0.4 mm shorter than eyes in men, 23.5 mm *versus* 23.9 mm. The corneal optical power was slightly greater in women eyes, 44.2 diopters *versus* 43.4 diopters.

Lenses inserted into female eyes had 0.3 diopters higher dioptric power than lenses inserted into male eyes (women: 18.9 diopter *versus* men: 18.6 diopter). Previously, Bishara et al. (1988) found a 0.38 diopters sex difference and Richards et al. (1986) a slightly higher, 0.92 diopters.

There was a slight preponderance of right eyes in the material (53.4%), and if operations on the patients' second eyes are analysed, there was a slight preponderance of left eyes (56%).

The preoperative planned refraction changed from slight myopia (-0.81 diopters) for 1986 towards planned emmetropia (-0.23 diopters) for 1990. A similar result was previously noted by Richards et al. (1986).

In the population studied, 77.9 per cent had less than 1.5 diopters of astigmatism. The distribution is similar to that published by Hoffer (1980). There was no difference between the sexes, as noted also by Richards et al. 1986 and Bishara et al. 1988. When considering the distribution of the direction of the meridian of greatest corneal power, vertical and horizontal directions were seen to dominate, and were approximately equally common.

The recorded prevalence of some relevant concurrent eye diseases showed that macular changes were significantly more common in women than in men. Diabetes was more common in men than in women. Between the sexes no difference in the incidence of glaucoma was found. In general, the figures are similar to what has been published previously (macular degenerations: Sperduto & Seigel 1980, Liu et al. 1989, Klein & Klein 1982; diabetes: Perkins 1984; Ederer et al. 1981; Leibowitz et al. 1980; glaucoma: Leibowitz et al. 1980).

5.2.2. Astigmatism, corneal optical power, axial length

Using the 45°-135°-model (with and against the rule), men had more against-the-rule astigmatism, >0.5 diopters

(56.5%). This tendency was not found in women (50.0%).

The against-the-rule astigmatism (assessed as Kpol) increased significantly with age. Similarly, the against-the-rule astigmatism (Kpol) increased with increasing intraocular pressure. There was a shift towards with-the-rule astigmatism (Kpol) in both genders with increasing axial length. For all three analyses, men had less with-the-rule astigmatism than women. The amount of astigmatism, no matter the direction, was the least for "emmetropic axial length values". A second degree polynomial equation was found to give a reasonable fit.

Using linear regression, a 1 mm change in axial length was found to correspond to a change of 0.37 diopters in corneal optical power. We did not find any significant sex difference in the rate of change in cornea power with the axial length. A second degree polynomial was found to give a better fit than a linear regression.

There was a yearly rate of eye shortening of 0.013 mm, with no sex difference. With increasing intraocular pressure there was a statistically significant increase in the axial length for men. If anything, there appears to be a slight decrease with increasing intraocular pressure in women, but the statistical significance is not impressive considering the large number of persons ($p<0.05$).

If women and men were treated separately, all ages included, there was a significant change of cornea optical power with age in men, but not in women.

When the directions of the astigmatism (meridian of greatest corneal power) were grouped in 30°divisions, the vertical meridian (60° to 120°) in eyes with an absolute value of astigmatism >0.5 diopters was the most prevalent in young patients (15-64 years of age), progressively diminishing with age. The difference in the proportion of horizontal and vertical meridians of greatest power between the age groups was statistically significant. This fits well with the K_{pol} analysis given above.

5.3. Observations at surgery (IV)

5.3.1. Complications at surgery

The total number of capsule or zonule ruptures at surgery (with or without loss of vitreous) was 142 (2.5%) out of a total of 5661 operations (al cases). We found no significant influence by age and sex on the risk for complications at surgery.

The rest of the figures in this section are based on one eye per patient (4942).

The relative risk was 2.7 for capsule or zonule rupture when the patient had glaucoma.

We found that surgeons with very few operations (in total <40 operations in 5 years) had a 2.9-fold increased risk for complications. When the 1990 figures for phacoemulsification were compared with figures for large incision extractions, we found an increased relative risk factor of 3.7. Besides this there were no statistically significant increases in the risk for complications when comparing the two methods of operations.

5.4. Postoperative observations (V, VI, VIII)

5.4.1. Retinal detachments

When all retinal detachments, retinoschisis' and tears were included, the total number was 40 eyes. A detachment was thus observed in 40/5634 = 0.71% of the eyes during the up to seven years postoperative period analysed here (average follow-up: 50.7 months). We found that the patients with retinal detachment were younger than those in the group without retinal detachment (the difference in the medians was 21.4 years). In the non-detachment group men were younger than women (the difference in the medians was 2.7 years), but there was no statistically significant gender difference in the detachment group; probably due to the small number of patients.

Patients with retinal detachment had greater axial lengths than the group without. The difference in the medians was 1.15 mm. In the eyes with retinal detachment, there was no gender difference in the axial length of the eyes, but in the non-detachment group men had longer eyes than women (the difference in the medians was 0.50 mm).

The corneal curvature was steeper in eyes without retinal detachment (the difference in the medians was 1.06 diopters). In the non-detachment group, women eyes had steeper corneas than men (the difference in the medians was 0.75 diopters).

In Cox's proportional hazards regression model analyses, age was found to protect against retinal detachment. An increase in age by one year corresponded to a hazard ratio of 0.94 (and thus a decrease in the relative risk of approximately 6%).

Of the 24 retinal detachments eyes, twelve had received YAG-laser capsulotomy treatment before the detachment. For the twelve in the YAG treated group, the median time from the cataract extraction to the retinal detachment was 32.6 months. In the non-YAG group the median was 14.0 months. Within six month after surgery, 3.2% had had capsulotomy performed and 8.7% after one year.

Postoperative YAG-laser capsulotomy was found to correlate positively with retinal detachment. The hazard ratio was 4.88. Large axial length was a risk factor for retinal detachment also in these cases. An increase in axial length of one mm give a hazard ratio of 1.30. Gender or type of operation or lens capsule rupture at surgery was not found to have any significant influence on the retinal detachment incidence in these cases.

5.4.2. Nd:YAG-laser capsulotomies

A total of 1380 patients had YAG laser capsulotomy, 983 in women and 397 in men.

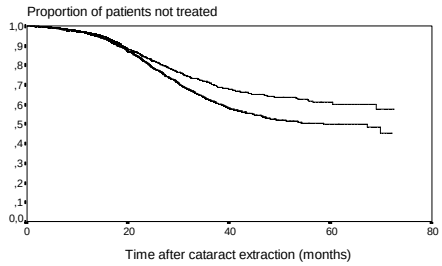

Fig. 3. Kaplan-Meier plot of cataract patients not treated with YAG laser

capsulotomy. Above, men; below, women.

After about four to five years around 50 per cent of the women and 40 per cent of the men had been treated (fig. 3). Note that these percentages are based on a survival analysis, minimising the confounding effect of the limited remaining life span of these elderly patients

Analysing the influence of patient age at surgery with Cox's multi-regression survival statistics, we found a yearly relative risk of 0.993. The risk for having a postoperative YAG laser capsulotomy is thus inversely proportional to age.

There was a relative risk of 0.742 for later laser capsulotomy when the cataract patient was a man.

Glaucoma eyes only showed a statistical significant decrease in the relative risk for capsulotomy if sphincterotomy as a covariate was removed from the Cox's survival analysis.

A patient from the small rural community of Orup (and perhaps also Ystad) had significantly fewer postoperative capsulotomies compared to patients from the city of Lund. This was found using one parameter Cox's regression survival analysis. In 1990 Lund had 160067 inhabitants, whereas Orup had about 54201 and Ystad 54487. The relative risk for patients living in Orup and Ystad was 0.764 (p=0.0024) and 0.861 (p=0.050), respectively. In the multiple proportional hazard regressions model, the relative risks remained unchanged, 0.738 (p=0.0006) and 0.870 (p=0.068) respectively.

If a sphincterotomy was performed during the operation, the relative risk for later laser capsulotomy was 0.721.

For the statistical analysis, the operation date was scored as the number of months that had passed since the start of the study. When an operation was postponed one month, the risk for subsequent capsulotomy increased with a factor of 1.023.

In the univariate Cox's proportional hazards regression model we found an increase risk for capsulotomy when the intraocular lens implanted was of the multifocal or bifocal type. The significance disappeared in the multiple Cox's regression analysis.

A low incidence of posterior capsule pacification's has been described in diabetic patients (Gieselhart et al. 1989), but these findings could not be confirmed by others (Krupsky et al. 1991)**.** In our material, diabetes did not influence the risk for later capsulotomy, and the result was independent of whether or not the patient was on insulin or had a proliferative retinopathy.

5.4.3. Astigmatism and other observations

5.4.3.1. Postoperative astigmatism

Cataract surgery is often followed by a certain amount of astigmatism and by a change of it in the postoperative period. However, there are large variations in both its size and its change in the postoperative astigmatism. We have therefore analysed the variations and the influence of different explanatory variables on the postoperative astigmatism.

There are many ways to calculate and evaluate postoperative astigmatism. It is very convenient to express corneal astigmatism in a single variable. Unfortunately, it is not possible to maintain all information about the corneal curvature in one single parameter. Different solutions have been suggested, and due to its simplicity we have used polar values, Kpol, to express corneal astigmatism, knowing its pitfalls, (Naeser 1990, Ninn-Pedersen 1996b).

The equation for K_{pol} is

$$K_{pol} = M*(\sin^2\alpha-\cos^2\alpha)$$

where K_{pol} is the keratometric polar value of net astigmatism in diopters and M is the magnitude of net astigmatism in diopters. α is the meridian of greatest power in degrees.

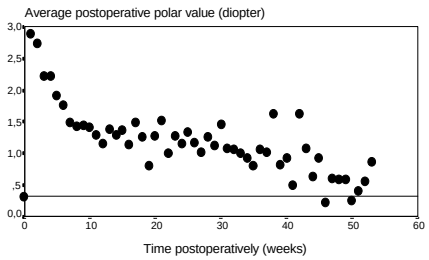

Fig. 4. Average postoperative astigmatism assessed as Kpol (polar value) and plotted against time (weeks). The solid horizontal line marks the average preoperative level of polar values. The number of measurements was 20 556.

There was a marked with-the-rule astigmatism in the early postoperative period, both the total as well as the induced, assessed as polar values. The postoperative astigmatism declined over time.

For each individual the relationship between the postoperative astigmatism (Kpol) and the time after surgery in days could be described by a linear model, $Kpol = b_0 + b_1*time$. However, a logarithmic transformation of the time parameter gave an improved fit, as verified by the sum of squared residuals. The model $Kpol = b_0 + b_1*(log(numbers\ of\ days\ after\ surgery))$ is therefore used. For every patient we thus obtained b_0, estimating the immediate postoperative astigmatism (day 1) and b_1, estimating the decline of the astigmatism.

To obtain reliable values of the decline of postoperative astigmatism in the individual patient, at least three measurements were required. Measurements obtained on the first postoperative day were excluded. They were often inexact for a number of different reasons like increased intraocular pressure, photofobia, corneal oedema or pain. This would influence the calculated astigmatism (Kpol). Therefore, we decided to use the extrapolated Kpol value (day 1) to represent the immediate postoperative astigmatism. The difference between the extrapolated Kpol value (day 1) and the preoperative Kpol value represented the induced astigmatism.

The figures below are the results of the multiple linear regression models.

Age and gender

Young patients were found to get more postoperative with-the-rule astigmatism. They also showed a faster decay rate of their astigmatism. The gender was not found to influence the postoperative astigmatism.

Operated eye

Operations on the right eye resulted in an increase in both the early with-the-rule astigmatism and the decay rate of postoperative astigmatism. The magnitude of this side-dependent astigmatism was on average small, and it is therefore unlikely that the side of operation is of clinical importance for the postoperative astigmatism.

Preoperative intraocular pressure

Higher preoperative intraocular pressure resulted in a diminished early postoperative with-the-rule astigmatism and a decline of the decay rate of astigmatism.

Preoperative corneal optical power

Stronger preoperative corneal optical power increased the amount of the postoperative with-the-rule astigmatism.

Preoperative astigmatisme

Eyes with more preoperative with-the-rule astigmatism also had more early postoperatively with-the-rule astigmatism and at the same time a faster decay rate of the postoperative astigmatism. If the "immediate postoperative astigmatism" as the response variable was substituted with the "immediate induced postoperative astigmatism" the multiple regression figures were identical except for the covariate preoperative astigmatism. One diopter higher preoperative with-the-rule astigmatism assessed as Kpol results in lesser induced postoperative with-the-rule astigmatism.

Diabetic patients

Insulin dependent diabetic patients showed a decrease in the magnitude of the early with-the-rule astigmatism and a decreased rate of change in postoperative astigmatism. The statistical significance for the change in magnitude was not impressive ($p=0.0495$), whereas the statistical significance for the decrease in the rate of change was slightly better ($p=0.009$). We see no biological reasons for these effects, and we suspect they are only statistical fluctuations.

Surgeons

Medium volume surgeons tended to have an decreased amount of early postoperative astigmatism compared to high volume surgeons. A decreased decay rate of postoperative astigmatism was found for the medium volume surgeons compared to the high volume surgeons. For the low volume surgeons no difference in the postoperative astigmatism was found compared to the high volume surgeons.

There were remarkable variations in the magnitude and the rate of change in the postoperative astigmatism between different surgeons, despite the fact that most of them used the same wound closure technique and had the same experience.

Operating date

If the time of the operation was postponed, this was related to an increased decay rate of astigmatism but had no influence on the immediate postoperative astigmatism.

Type and size of incision

Compared to mid limbal incisions anterior limbal incisions (corneal incisions) was related to a higher degree of immediate with-the-rule postoperative astigmatism and an increased decay rate of postoperative astigmatism, the latter difference was not statistical significant ($p=0.062$). It was the other way around for scleral pocket incision (posterior limbal incisions).

A large wound incision was related to a decreased in the with-the-rule postoperative astigmatism. However, it had no influence on the decay rate of astigmatism.

Type of extraction

Phacoemulsification was found to create a decreased postoperative with-the-rule astigmatism and a decreased decay rate of the astigmatism. Secondary implantation of an intraocular lens result in lesser immediate postoperative astigmatism.

Sphincterotomy at surgery

There was a remarkably reduced amount of early postoperative with-the-rule astigmatism and a reduced rate of astigmatism change postoperatively when a sphincterotomy was performed.

Complications at surgery

Capsular or zonule rupture were the complications recorded at surgery. They showed a slight correlation with postoperative astigmatism, but the statistical significance was small. Therefore, the clinical importance of this variable is also likely to be small.

5.4.3.2. Other observations

Surgery induced a statistically significant change in the corneal optical power. When comparing the postoperative values with measurements at 30 days and up to 32 weeks after the surgery, they increased from 43.9 to 44.1 diopters. Further, the intraocular pressure fell from 16.6 to 14.2 mm Hg in the same period of time. The median values of visual acuity (both corrected and uncorrected) in the postoperative period are shown in Fig. 5.

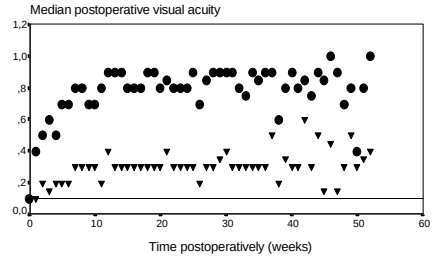

Fig. 5. Average postoperative visual acuity (medians) and time in weeks. The solid horizontal line marks the average preoperative level of the visual acuity. Solid dots represent corrected visual acuity and solid triangles represent uncorrected visual acuity.

6. DISCUSSION

It is important to be aware that patients in the population studied are operated on because of cataract. Conditions such as myopia, old age, female gender, or different kinds of illnesses are factors which are known to predispose for cataract development. Compared to the general population, a greater percentage with these conditions is likely to be found among patients with a cataract to be removed. Further, some groups of individuals with cataract may not be referred to surgery simply because they are satisfied with their visual status or they are not aware of their visual problems or do not ask for surgery because of some other severe disease. These observations must be borne in mind when assessing the results presented here. They are not necessarily comparable

with results obtained in other cohorts, for instance the entire population. On the other hand, they do represent the situation in a large and well defined population, those requesting cataract surgery among about 380 000 inhabitants in South Sweden.

6.1. Demography and epidemiology (I, VII)

6.1.1. Resources and epidemiology

The increase in the number of cataract operations in the 1980:s is impressive, both in Sweden and in Lund. There were no important changes in the age distribution in the population during the period studied. The pseudophakic patient experiences much better visual abilities and comfort than the aphakic (Stark et al. 1983, 1989, Bernth-Petersen 1985), and it therefore appears that at least in part the strong increase in the demand for cataract surgery has been elicited by the improvement offered by implanting intraocular lenses. There was also, with a one year delay, a rise in the percentage of operations on the patients' second eyes. It has also been seen in a number of previous and later studies that women predominate (Caird et al. 1965, Perkins 1984, Hiller et al. 1983, Leske & Sperduto 1983, Richards et al. 1986, Leibowitz et al. 1980, Bishara et al. 1988, Stenevi et al. 1995). Of the several reasons possible for the difference between the sexes, the most likely appears to be that women are more prone to develop cataracts than men, as found in the Framingham population survey (1980), where 67% of the cataract cases above 85 years of age were women. The figure for women in the age group 80-89 years in the present material of cataract surgery is very similar, 72%. However, other factors than prevalence may also be involved, because men tend to accept a larger visual loss than women on the eye to be operated before they request surgery (Ninn-Pedersen et al. 1994b).

We conclude that because the increase in the number of patients which were operated on did not result in a drop in the average age at surgery, a new category of patients was added. Consequently, we do not foresee any substantial drop in the future demand for cataract surgery.

6.1.2. Mortality and cataract

All patients except six were found in the National Population Register, where their death dates and death diagnoses are recorded. We find it likely that the figures presented here come close to representing the true standardised mortality ratios in the different patient groups. It should be noted that only one eye for each of the 5120 patients operated during 1986 through 1990 were included. The results are similar in the Framingham investigation (Podgor et al. 1985), the Beaver Dam Eye Study (Klein et al. 1995) and the study of Street & Javitt (1992), even though they were not designed in the same way.

There are reports suggesting that cardiovascular diseases correlate with increased mortality among cataract patients (Thompson et al. 1993; Rogot et al. 1966). In this study, it was true only for young patients undergoing inpatient cataract surgery. There is a strong bias towards patients of poor general health in this group, and the increased mortality rate is therefore hardly surprising. In fact, there is consistently a higher mortality rate among inpatients than in outpatients, and selection bias is the most likely explanation for this.

The death risk factors that by life-table regression analysis were found to be statistically significant were age, gender, diabetes, preoperative rheumatoid arthritis, age-related macular degeneration, preoperative intraocular pressure and whether or not the patient had a YAG-capsulotomy postoperatively. Intraocular pressure was marginally significant. Of these, age and sex can be regarded as trivial, reflecting well known demographic facts. Diabetes will be discussed separately. Rheumatoid arthritis has not been associated previously with any increased standardised mortality ratio in cataract patients, but is known that in general, such patients have an increased mortality risk, comparable to the figure found here (Wolfe et al. 1994). That survival decreased with the present of age-related maculopathy is consistent with the Beaver Dam Eye Study (Klein et al. 1995) even though the influence disappeared in that study when the presence of visual impairment was included in the multiple Cox's proportional hazard model. We have not included visual acuity as a covariate in the present analyses. The reason for the inverse correlation with YAG laser capsulotomy and mortality risk is probably that it is mainly the healthy patients with capsular haze which request YAG laser capsulotomy.

Diabetics showed a much increased standardised mortality ratio in this study, almost fivefold in the young inpatient group and less but still increased in the others. Further, the life-table regression analysis showed that diabetes is one of the factors that influence the death risk in cataract patients. This is at variance with other studies by Hirsh & Schwartz (1983) and Benson et al. (1988) where diabetes was not a factor that significantly altered the relative mortality. However, in these studies the total number of cataract patients was not very high (167 and 193 respectively) and consequently the number of diabetics was small (not reported in the study by Hirsh & Schwartz, 40 in the study by Benson et al. and 571 in the present study). Furthermore, the cataract patients were not compared with the normal population, but with patients undergoing other kinds of surgery. Both these factors may have obscured the influence of diabetes. Selection bias may also have been present, because the studies were limited to patients choosing to have surgery at the hospital at which the investigations were made. On the other hand, based on the large, population-based Framingham study Podgor et al. (1985) found an inverse association between lens changes and survival in diabetics but not in non-diabetics. Among diabetics, lens changes were associated with more than a doubling of the death rate. We concur with Ederer et al. (1981) that diabetes is correlated with an increased death risk in cataract patients.

In this study, we have not seen any increased standardised mortality in cataract patients aged above or equal to 75 years, and only in patients below 75 is there an increased standardised mortality ratio. This is in good agreement with the recent Beaver Dam Eye Study (Klein et al 1995), where increased mortality was found to be associated with age, sex and a number of systemic factors rather than cataract itself. Our results also agree with the Framingham study (Podgor et al. 1985), with mortal-

ity ratio results in Medicare beneficial (Street & Javitt 1992), and with the smaller study of Cvetkovic et al. (1985), where the mortality of cataract patients was compared with spouses and other relatives. In fact, there is in our data a decreased standardised mortality ratio in patients that have undergone cataract surgery. Whilst this may be encouraging, we suggest that the observation is more likely due to selection bias than to an effect of the surgery. Simply, chronologically old but biologically young patients are more likely to request cataract surgery than patients which are old in both respects.

6.2. Preoperative observations (II, III)

6.2.1. Preoperative observations

The visual acuity when surgery is performed has risen significantly during the studied period, very likely as a consequence of the increase in the number of operations, because this is the only relevant factor that is known to have changed. This applies to operations on both the first and the second eye of the patient. Note that the figures for visual acuity reported here concern the eye that was operated on, and most often not to the vision of the patient's best eye. We nevertheless find it likely that, on average, the patients in 1990 endured less preoperative visual handicap than patients did in 1986. Batterbury et al. (1991), Moorman et al. (1990) and Stenevi et al. (1995) made similar observations. However, this does not mean that patients on average were operated on at an earlier age (Ninn-Pedersen et al. 1994a). The result shows that as weighed by the surgeons and patients, the cataract surgery procedures in 1990 were much more beneficial to the patient than the procedures used before 1986.

Men operated on for cataract have on the average slightly longer eyes than women. Similarly, Richards et al. (1986) and Bishara et al. (1988) found that women have shorter eyes than men, a difference noted by anatomists already in the 19th century (Sappey 1855; see Duke-Elder and Wybar 1961 p. 80-81). Small eyes should have a steeper corneal curvature than large eyes (Hoffer 1980). The power of the lenses inserted into men eyes tend to be less than the power of lenses inserted into women as noted previously (Richards et al. 1986, Bishara et al. 1988).

There is a slight preponderance for right eyes in the surgical material. In the Framingham study, there were also slightly more right (56%) than left eyes (44%) in persons in which cataracts were found in only one of the eyes (144 cases). It thus seems possible that cataract is more prevalent in the right eye than in the left. On the other hand, if the cataracts are about equal in a patient's eyes, the surgeon may well opt to operate on the presumed leading eye, i.e. most often the right eye. Patients tend to be more satisfied if being slightly myopic than slightly hyperopic, and on average the surgeon therefore aims at making the patient myopic rather than emmetropic or hyperopic. However, this tendency declined in the period studied. There are several possible reasons for this. One is the increased experience of the surgeon when the numbers have gone up, making him more confident he can reach emmetropia. Another may be improved preoperative assessments, and there may also be several others.

6.2.2. Astigmatism, corneal optical power, axial length

A small degree of with-the-rule astigmatism is the usual condition in early life (Duke-Elder & Abrams 1970). The changes in corneal astigmatism with age are less marked or slower in women than in men (Duke-Elder & Abrams 1970). There are also several previous studies suggesting a change from with-the-rule to against-the-rule astigmatism with age men (Duke-Elder & Abrams 1970; Weale 1982). Consequently, one might expect old men to have more against-the-rule astigmatism than old women, which is also the result seen in the present study. The gender differences were fairly small, like in all eyes analysed here, and currently probably of only small clinical relevance, even though they may be significant from a mathematical statistical point of view. However, with the increasing demands for precise results, we anticipate that they may be more important in the future. The K_{pol} values show a general shift with increasing patient age toward against-the-rule astigmatism which agrees well with the change in the direction of the astigmatism axis discussed above.

The K_{pol} values tend to increase with the axial length and the proportion of meridians in the 60° - 120° range also increase with increasing axial length of the eye. Again, despite the fact that the K_{pol} values take the amount of the astigmatism into account, the results point in the same direction. Further, we have shown that the amount of the astigmatism tends to increase the more the axial length deviates from the normal. It is as if when the length of the eye is out of precise control, the same applies also to the shape of the cornea. It is interesting to note that there are previous observations suggesting that the shape of the cornea is dependent on the size of the eye. Jackson (1932) noted that hyperopic patients shift toward against-the-rule astigmatism with age, whereas myopic patients shift more toward with-the-rule astigmatism. Since it is now known that the size of the eye is actively regulated (even though the mechanism for this is largely unknown; Raviola & Wiesel 1990), it might also be the case for the shape of the cornea. The intraocular pressure also relates to the astigmatism, both when expressed as K_{pol} values or simply as the direction of the astigmatism. With increasing pressure, the proportion of patients having astigmatism with-the-rule decreases, as do the K_{pol} values. This effect has been noticed in the eyes of experimental animals (Duke-Elder & Abrams 1970). We are not aware of any previous population study showing a relation between intraocular pressure and the direction of the astigmatism.

In men with high intraocular pressure, the eye is significantly longer than in men with low intraocular pressure. In women, the effect is not present. A similar observation was previous made in school children (Pärssinen 1990), but the phenomenon remained unexplained. The men are on average younger than the women in this study, and they have larger eyes. Perhaps men's eyes are therefore more easily deformed than women's eyes, but other explanations have not been excluded.

Table 1. Multiple linear regression models for the polar value of astigmatism (Kpol), the corneal optical power and the axial length. One eye per patient (4564 cases). The value of b represents the regression coefficient.

Dependent variable	Polar value			Corneal Optical power			Axial length		
Adjusted R^2	0.07			0.16			0.13		
	b	p-value	CI95%	b	p-value	CI95%	b	p-value	CI95%
Sex (F=0, M=1)	-0.116	<0.0001	-0.157, -0.074	-0.643	<0.0001	-0.733, -0.552	0.193	<0.0001	0.114, 0.272
Age (years)	-0.016	<0.0001	-0.179, -0.014	0.003	0.14	-0.001, 0.007	-0.012	<0.0001	-0.016, -0.009
Axial length (mm)	0.037	<0.0001	0.022, 0.053	-0.370	<0.0001	-0.402, -0.338			
Corneal optical power (diopters)	0.020	0.0025	0.007, 0.033				-0.272	<0.0001	-0.230, -0.248
Intraocular pressure (mm Hg)	-0.008	0.0012	-0.013, -0.003	0.013	0.022	0.002, 0.023	0.009	0.066	-0.0006, 0.018

The axial length is significantly longer in young cataract patients than in old. The reason for this could at least in part be that myopic patients tend to develop their cataracts earlier than non-myopic ones (Weale 1982; Sorsby 1971; Leighton & Tomlinson 1972). Theoretically, the effect should also arise if axial myopic patients have a shorter life span than non-myopic which actually is not the case (Ninn-Pedersen 1996b). Finally, the eye may actually shrink with age, and this has been suggested several times, but there is no definite evidence in favour of it (Fledelius 1988).

There is a relation between the axial length of the eye and the corneal refractive power. However, the plot also shows that the relationship is not linear. At the extremes, both long eyes and short eyes tend to have an increased corneal power. As far as we are aware, this has not been noted before. Equations for calculating the lens to be inserted after a cataract extraction are often of the first degree, assuming a linear relationship between the required power of the lens and the factors entered. Such equations give poor results for myopic or hyperopic eyes, and empirical correction factors are therefore usually introduced. The observation here that a second degree equation improves the description of the relation between the axial length and the corneal power suggests that equations for calculating the power of intraocular lenses should similarly not be linear.

A few of the observations in the analysis were difficult to understand and of weak statistical significance. We have therefore continued our analysis of the data, using multiple linear regression models for the dependent variables Kpol, the corneal optical power and the axial length (Table 1). The explanatory variables were the same as the ones tested in the previous simple linear regressions. The major conclusions remained the same. Notice that the corneal optical power now significantly influenced the polar value (Kpol), although the clinical relevance of this appears to be slight. The inexplicable correlations between the intraocular pressure and axial length as well as the corneal optical power and patient age both disappeared in this analysis.

6.3. Observations at surgery (IV)

6.3.1. Complications at surgery

Age and sex do not seem to have any influence on the complication ratio at surgery in our material. This was also found by Guzek et al. (1987) in a study on 1000 cataract operations. Küchle et al. (1989) found that patients under 41 years of age had an increased risk of capsule rupture. In the present study only 75 patient under 41 years of age fulfilled our inclusion criteria, and this small number could be the reason why we did not find any statistical significance.

In the literature it seems to be glaucoma related variables rather than glaucoma itself that dispose to zonule or capsule rupture at surgery (Moreno et al. 1993; Guzek et al. 1987; Naumann et al. 1989; Zetterström et al. 1992; Lumme & Laatikainen 1993). The pseudoexfoliation syndrome and poorly dilated pupils have been shown to be statistically significant risk factors for complication at surgery. In our study we did not score the size of the pupil at surgery, and neither did we register if the patient had pseudoexfoliation or not. Our glaucoma patients are likely to have small pupils and to have pseudoexfoliations. Therefore glaucoma, as an epiphenomenon, was related to capsule or zonule rupture at surgery with good statistical significance.

Glaucoma was more common in in-patients than in out-patients; 14.5% and 4.4% respectively. Most likely, this is one of the major factors that explain the higher incidence of complications among in-patients, because they were usually feebled by old age, complicating diseases or social problems, and the incidence of manifest glaucoma increases with age (Leibowitz et al. 1980). This is supported by the fact that in a logistic regression analysis which included glaucoma, the higher risk for complications among in-patients disappeared.

It seems likely that inexperienced surgeons have a significantly higher complication rate than others. This agrees well with the study by Browning & Cobo (1985) showing that residents in training run an increased risk of various complications at surgery.

In a study by Kuchynka et al. (1992) there was an increased amount of posterior capsule rupture because phacoemulsification was introduced as a new procedure. An increasing number of surgeons used this technique in the last two and a half years of the period studied, and this most likely explains why in 1990 the relative risk for complications with phacoemulsification was as high as

3.7, comparing with the previous surgical technique.

A long eye is associated with more postoperative complications than an eye with a normal length (Ninn-Pedersen & Bauer 1996a). Predisposing factors such as increased axial length and multiple retrobulbar injection leading to globe perforation have been implicated by Ramsay & Knobloch (1978). Rosen (1962) also hypothesised that scleral thinning from posterior staphyloma and increased axial length may be significant predisposing factors for ocular perforation. However, we have in the literature not been able to find any evidence suggesting that a long eye has an increased risk for capsule or zonule rupture (Guzek et al. 1987: Kuchle et al. 1989). In our study, there was a decreased risk for capsule ruptures and the regression coefficient remained the same when going from simple to multiple logistic regression analysis but the statistical significance was not impressive and disappeared in the multiple logistic regression model. This suggests that even though axial length may perhaps have some influence on the complication rate, the connection is not likely to be strong.

6.4. Postoperative observations (V, VI, VIII)

6.4.1. Retinal detachments

With an average follow up time of 50.7 months the total risk of retinal detachment was in this study 0.71% and 0.43% when certain high-risk cases were excluded. There were eight such high-risk cases, including two patients with dense cataracts in which retinal detachments were discovered at surgery. These cases were registered as preoperative detachments. One case had a preoperative narrow angle glaucoma on both eyes with intraocular pressure of 68 mm Hg and 58 mm Hg in her right and left eye, respectively. The intraocular pressure was intractable with medication and the patient was operated on with a combined procedure on both eyes (cataract surgery with trabeculectomy). In one eye, intraocular hemorrhage and retinal detachment ensued surgery, but there were no complications when the other eye was operated. One patient with a treated preoperative retinal detachment and uveitis because of lymphoma developed a retinal detachment after her cataract extraction. One patient with secondary implantation of an intraocular lens developed a detachment three years after the implantation. The primary cataract extraction was done before this study. Two patients with partial retinal detachments had their cataracts removed in order to get a better view of the retina. After the cataract operation, the detachment progressed. One case with a hereditarily luxated lens operated on with intracapsular technique develop a retinal tear postoperatively.

The risk for a detachment to occur within the first two years after cataract surgery was 0.18%, high-risk cases excluded. The result is more favourable than the risk for retinal detachment reported in a number of other studies, in which figures have ranged up to 3.6% after extracapsular cataract extraction (Smith et al. 1987; Nielsen & Naeser 1993). On the other hand, our results are similar to figures published from other regions in Northern Europe (Nielsen & Naeser 1993; Kraff & Sanders 1990; Hünemohr et al. 1992). We as well as others (Nielsen & Naeser 1993) have shown that there is a highly significant association between patient age at the cataract surgery and the risk for retinal detachment. One of the reasons for the differences in different studies may therefore relate to the patient age at surgery. In their review of pertinent studies, Nielsen & Naeser (1993) also noted that this may well be the explanation.

The above results from the literature may be biased, since no account is taken of the deaths occurring in the study population. From our cohort of 5634 eyes (4916 patients) with cataract in which 24 retinal detachments occurred, we have used survival analysis to estimate risk factors. Among a dozen factors analysed, three turned out to be significant: age, postoperative YAG-laser capsulotomy, and axial length.

Of the three factors found to influence the risk for postoperative retinal detachment, the age of the patient was found to be the most significant. The younger the age the greater is the risk for retinal detachment. This is as expected, as judged from most previous studies (Nielsen & Naeser 1993; Laatikainen & Tarkkanen 1985; Laurell 1993; Davison et al. 1988).

The axial length of the eye has previously been found to influence the risk of retinal detachments (Smith et al. 1987; Laatikainen & Tarkkanen 1985; Laurell 1993; Dardenne et al. 1989). However, to our knowledge, the association between the corneal refractive power and the risk for retinal detachment after a cataract operation has not been noted before. We found a statistically significant difference in corneal power between the eyes with and without detachment, but in the Cox's proportional hazard model, it did not influence the risk for retinal detachment. This is most likely because the corneal power is dependent on the axial length of the eye, which was included in the Cox's model and which is likely to be the more significant variable of the two.

Previous observations suggest that men may have a higher risk for retinal detachment after cataract surgery than women (Javitt et al. 1991; Laatikainen & Tarkkanen 1985; Hurite et al. 1979). We have not been able to confirm this in our study population, when taking all parameters into account simultaneously in the Cox's proportional hazards models. If, on the other hand, the gender is examined separately, men seem to run a higher risk than women. We have found the factors age and axial length to be associated with the risk for postoperative retinal detachment. Our analyses thus suggest that there is no further influence from gender when age and axial length are accounted for.

YAG-laser capsulotomy has also been suggested to influence the risk for retinal detachment (Javitt et al. 1991; Dardenne et al. 1989). Other studies have been unable to confirm this (Laatikainen & Tarkkanen 1985; Nielsen & Naeser 1993). In the present analysis, the YAG-laser operation was found to increase the risk for retinal detachment with a hazard ratio of 4.9. This is very similar to the finding in the study by Javitt et al (1991), were YAG-laser capsulotomy was seen to increase the risk for retinal detachment 3.9-fold. Fifty percent of the eyes with retinal detachments in our study had undergone YAG-laser capsulotomy. Examining differences in the time elapsed be-

tween the cataract surgery and the YAG-laser capsulotomy did not result in lesser risk in our study for retinal detachments. In Javitt's study, about 7% of the patients had undergone YAG-laser capsulotomy within 6 months and about 13% within 12 months. In the present study population, the corresponding figures were smaller, 3.2% and 8.7%, respectively. However, in this study, the average time between cataract surgery and YAG-laser capsulotomy was 24.67 months, which is not significantly shorter than in the detachment group, 23.23 months.

6.4.2. Nd:YAG-laser capsulotomies

Secondary cataract is hard to define in exact clinical terms because it is not a single, well defined entity that easily can be quantified, but rather a condition after a cataract operation which makes the patient (or his or her doctor) unsatisfied, one way or the other. We have therefore used YAG laser capsulotomy as the criterion for a clinically significant secondary cataract. The patients presented here form a homogeneous group in the sense that they all came from a very well defined health care district, and that they were operated on by a small number of surgeons at a single department (Ninn-Pedersen et al. 1994a and b).

Old patients have previously been found to run a lower risk of developing posterior capsule opacification (Apple et al. 1992; Mackool et al. 1991; Maltzman et al. 1989; Metge et al. 1989; Morrell & Pearce 1989; Jacob 1987; Emery et al. 1978), which agrees well with the present results. We found the risk for YAG laser treatment to decrease by about 7% per decade, an estimate not obtainable from previous studies.

In a study by Emery et al. (1978), women were seen to develop more posterior capsule pacification's than men. However, this is not uniformly so. In a study by Westling and Calissendorff (1991) there was no sex or age difference in the risk for developing a need for capsulotomy. In the present study, women more often needed treatment that men, and this difference was highly significant statistically. Note that we have in this study eliminated the confounder that women live longer than men. We conclude that women run a higher risk than men for needing a YAG laser capsulotomy.

Spincterotomy is most often performed in eyes with a small pupil. We found that if it was performed, there was an around 30% lower risk for a subsequent need for YAG laser treatment. An irritation of the iris may cause a higher incidence of posterior capsule opacity (Gunning & Greve 1991). Our figures nevertheless suggest that the referring ophthalmologists were reluctant to have YAG laser capsulotomies done in sphincterotomy patients, perhaps because their eyes were seen as more vulnerable. In our material, glaucoma eyes more often had sphincterotomy and less often had capsulotomies than other eyes. This is not as expected, because in the literature, glaucoma is often associated with an increased incidence of posterior capsule opacification (Gunning & Greve 1991). Further, Sommerauer et al. (1990) found a capsule haze ten times more frequently in eyes with the pseudoexfoliation syndrome than in normal eyes. The discrepancy between the information present in the literature and our results is difficult to explain. It appears likely that factors not included in this study may play a larger role than expected.

We found that patients from Lund operated for cataract more often had laser capsulotomy compared to patient from the smaller towns of Orup and Ystad. The number of citizens and their survival figures have been taken into account in this analysis. The reason for the difference could be that patients in urbanised regions tend to consult doctors more often than patients from rural regions. We find it hard to assume that people in rural areas should develop less posterior capsule opacifications than people in urbanised regions, and there is no support for such an assumption in the literature.

Patients operated for cataract towards the end of the studied period more often had capsulotomies performed than patients operated on in the beginning. We assume that with growing awareness of the power of the procedure, there was an increased demand for capsulotomy by the patients, the referring ophthalmologists, or both. Other explanations are conceivable, but we see no support for them.

Eyes receiving multifocal and bifocal intraocular lenses both tended to need laser capsulotomy more often than eyes with standard lenses. However the statistical significance disappeared in the multiple regression analyses, and the regression coefficients were not quite stable. Further, the number of different types of intraocular lenses was small and other variables also have an impact on the risk for YAG laser treatment. Therefore, we cannot conclude that multifocal or bifocal intraocular lenses increase the risk for posterior capsular haze.

6.4.3. Astigmatism and other observations

6.4.3.1. Postoperative astigmatism

Age

It is well documented that there is a change of the astigmatism with age (Duke-Elder & Abrams 1970; Weale 1982; Ninn-Pedersen 1996b), generally going from with-the-rule to against-the-rule. However, we have not found any previous information on postoperative astigmatism in relation to patient age. Nevertheless, the figures presented here unequivocally show that young age predisposes for a higher degree of postoperative with-the-rule astigmatism together with a steeper slope of change in it. Although the effect is clear, it is not large, which may explain why it has not been noticed previously.

The data presented here do not show any reason for the effect, but it could be that the surgeon is more inclined to tighten up the sutures in young patients in order to stabilise the incision better. However, other explanations have not been excluded.

Preoperative intraocular pressure

It is well-known that the intraocular pressure and the spherical refraction status of he eye are related (Poinoosawmy & Roth 1974; Pärssinen 1990; Thorntorn and Sanders 1987). In particular, Poinoosawmy et al. (1987) found that the corneal curvature increased in both meridians when the intraocular pressure was raised, but did not discuss whether there was a differ-

ence in the two. However, in a cross-section study (Ninn-Pedersen 1996b) we found that the preoperative against-the-rule astigmatism (assessed as Kpol) in cataract patients increased with increasing intraocular pressure. There appears to be no previous studies concerning the relationship between the preoperative intraocular pressure and postoperative astigmatism.

In the present study it was found that the postoperative intraocular pressure decreased after the cataract surgery ($p<0.00001$). From another study on cataract surgery (unpublished), we observed a statistically significant ($p<0.0001$) relationship between the preoperative and postoperative intraocular pressure showing a 0.27 to 0.39 mm Hg increase in the postoperative value when the preoperative intraocular pressure increased 1 mm Hg.

That high preoperative intraocular pressure results in lesser postoperative with-the-rule astigmatism therefore makes sense. The relationship between a steeper decay in postoperative with-the-rule astigmatism and a low preoperative intraocular pressure is a new finding.

Preoperative astigmatism

Although there are fluctuations in the estimates, especially in the slope parameter, the tendency is obvious that large with-the-rule astigmatism before cataract surgery predisposes for large with-the-rule postoperative astigmatism. If a patient operated on because of cataract had a preoperative meridian of greatest power at the 12 o'clock position it is plausible that closure of an incision at the same location will end up with an astigmatism at the same position. We have not found any previous cataract population studies in the literature on this matter although it is mentioned in a review by Swinger (1987) that the final astigmatic error depends in large part on the preoperative astigmatism. That a large preoperative with-the-rule astigmatism results in a relatively lesser "immediate" induced postoperative with-the-rule astigmatism is a new finding.

Surgeons

There are in this study strikingly large variations between individual surgeons in both the magnitude of postoperative day 1 astigmatism and its decay rates, also between surgeons having similar clinical training and experience, working closely together in the same department and purportedly using the same surgical procedure. Procedural details that might be used to explain the differences were not recorded in this study. All surgeons but one used running 10-0 nylon sutures as their routine when closing the cataract incision. It is therefore impossible to make any comparison between the wound closure techniques, especially with the enormous variations in the change in astigmatism and the amount of postoperative astigmatism between surgeons with the same surgical technique. Statements in the literature support this view. One study claimed more (Jaffe & Clayman 1975), another less Stainer et al. (1982), and one no difference (Meredith & Maumenee 1979) in the amount of astigmatism in the early postoperative period when interrupted closure (10-0 nylon) was compared to continuos suturing of the wound. Only in a few cases were other suture materials used (such as mersilene or polypropylene) and changes between different kind of suture materiel are therefore not likely to have influenced the results in our study. It is known that such variables as the length and depth of the suture bite are involved in producing astigmatism following cataract surgery (Swinger 1987). However, these surgical details were not recorded and even though they might explain some of the variations seen in this study, this remains undetermined.

type and size of Incision

In the literature it is often stated that the amount of early postoperative astigmatism increases with the size of the incision (Swinger 1987; and Browning et al. 1985). In this study, such a connection is not evident, if also other factors like the type of operation (phacoemulsification) or position of the incision is included in the evaluation. Phacoemulsification as the type of operation and if the incision was placed posterior to the limbus thus seem to be more important as factors associated with less astigmatism. Previously, Leen et al. (1993) saw a similar effect for phacoemulsification, and the position of the incision relative to the limbus has also been seen to influence the degree of postoperative astigmatism (Swinger 1987). However, we do not have enough exact and detailed data on the incision and suturing techniques used in the cohort under study that would make it possible to draw any further conclusions.

Sphincterotomy at surgery

There appears to be no previous publications describing any connection between iris surgery and the development of postoperative astigmatism. However, in the present study, sphincterotomy was in all the regression analyses strongly associated with both a lesser amount of postoperative astigmatism and a reduced rate of change in the postoperative astigmatism. The factors examined in this study fail to explain this observation, and others will have to be sought.

6.4.3.2. Other observations

There was a marked with-the-rule astigmatism in the early postoperative period but the astigmatism, both total as well as induced, declined over time. All cataract extractions except the ones combined with keratoplasty were included.

We have in this study shown that cataract surgery results in a decrease in the postoperative intraocular pressure after a period of early elevation. The early elevation is a previously known phenomenon (Calissendorff et al. 1993), and the later decrease below the preoperative level in the intraocular pressure after extracapsular cataract extraction is also known clinically (Noske et al. 1989).

It is a new observation that the average keratometry power increases postoperatively. However, the effect is small, 0.2 diopters, and despite its high statistical significance, its clinical importance seems only slight.

It can also be seen that the overall results in terms of visual acuity is good in our patients. Because pre-existing eye diseases are not excluded it is difficult to compare these figures with other cohort studies. Note that we give the median for visual acuity values, thereby avoiding errors caused by the non-

linear measurement units used for low visual acuities.

7. GENERAL SUMMARY

7.1. Demography and epidemiology (I, VII)

With the Cataract Analysis System (CAS(TM)) we have analysed 5878 consecutive cataract patients operated from 1986 through 1990. The material is complete enough to be regarded as representative of the cataract surgery performed in the entire referral region of the Lund Health Care District during this period. There has been a striking increase in the number of operations, in 1990 reaching 3.6 per 1000 inhabitants in the referral region. Simultaneously, surgery has changed from being mainly an in-patient to an out-patient procedure. Females predominate in the material, also after adjustment for the female preponderance in the population. Most likely, this is due to a higher incidence of cataract in women than in men.

Despite the increased number of operations during the period studied there was no drop in patient age. We conclude that the increase in the number of patients which were operated on came about predominantly by cataract operations on patients which previously would never have had surgery at any age, that is, a new category of patients was added. Consequently, we do not foresee any substantial drop in the future demand for cataract surgery.

Inpatients almost always show an increased standardised mortality ratio, compared with outpatients. Young patients and diabetic patients also show an increased standardised mortality ratio, compared with the normal population, but not older patients, which constitute the majority. Cardiovascular death diagnoses were overrepresented among the young. In the Cox's proportional hazard regression analysis we found besides older age and male sex that diabetes, the presence of age-related macular degeneration and rheumatoid arthritis increased the relative mortality risk.

7.2. Preoperative observations (II, III)

In 1986, the cataract patients showed more visual impairment than in 1990. During the period, the planned refraction changed towards emmetropia, presumably reflecting several kinds of improvements in the procedure.

About 78 per cent of the population had a preoperative astigmatism < 1.5 D. As expected, males had slightly longer eyes than women, and their corneal curvature was also slightly less. Men had more against-the-rule astigmatism than women, and the preoperative astigmatism shifted for both sexes towards against-the-rule with age. Long eyes tended to have more with-the-rule astigmatism. Further, the amount of astigmatism was found to deviate more from the normal both in large and in small eyes. The with-the-rule astigmatism decreased with increasing intraocular pressure. Finally, a second degree polynomial model was found to give an improved description of the relation between axial length and keratometric powers.

Apart from confirming a number of previous observations, the study shows that the axial length of the eye relates to the direction and size of the astigmatism. It is as if when the control of the size of the eye is failing, the same applies to the shape of the cornea, as if the latter is also actively regulated.

The observation that a polynomial equation describes the relationship between the axial length of the eye and the optical power of the cornea better than a linear one suggests that equations for calculating the power of intraocular lenses should similarly not be linear.

7.3. Observations at surgery (IV)

This study of 5661 extracapsular cataract operations demonstrates that a cataract patient with glaucoma and operated on by an inexperienced surgeon runs a significantly increased risk for complications at surgery, as indicated by capsule or zonule rupture. Two variables, type of extraction and axial length, may have some influence on the complication rate, but their importance was less conclusive. A number of other parameters (patient age and gender, out- or inpatient surgery, right or left eye, cornea curvature and intraocular pressure, age-related macular degeneration, known history of diabetes, uveitis or rheumatoid arthritis), were not seen to influence the complication rate, assessed as the incidence of capsule rupture at surgery.

7.4. Postoperative observations (V, VI, VIII)

At two years after cataract surgery we found the risk for retinal detachment to be 0.18%. The follow-up period after cataract surgery was up to seven years with a mean of 50.7 months, and the total risk for retinal detachment or detachment related conditions was 0.71%, all cases included. The relative risk for detachment was found to be 4.9 after a YAG-laser capsulotomy. It changed by a factor of 1.3 with an increase in the axial length by one unit (=1 mm) and with 0.94 for each added patient age year.

Besides age, five variables significantly influenced the risk of having postoperative YAG laser treatment. They were gender, iris sphincterotomy, operation date and the community from which the patient came from. After about four to five years, the percentage of patients not having had a YAG laser capsulotomy was reduced to around 50% for women and 60% for men. These percentages were based on a survival analysis, minimising the confounding effect of the limited life span of these elderly patients.

In this material, the most important predisposing factors for rapid changes in the postoperative astigmatism were large preoperative astigmatism (polar value), young age, low preoperative intraocular pressure, if an ECCE were chosen as the extraction type and the surgeon. The same variables and, in addition, if the location of the incision was anterior to the limbus, were the most important explanatory variables in generating an early large with-the-rule astigmatism. Individual surgeons generated widely different amounts of postoperative astigmatism.

8. OVERSIGT PÅ DANSK

8.1. Kort resume

Denne populationstudie om kataraktkirurgi strakte sig over en pre- og peroperativ fase med indsamling af data i perioden 1986-1990. Den postoperative dataindsamling i denne redegørelse dækker perioden 1986-1992. Epidemiologiske forhold belyses i det første og syvende arbejde. Anatomiske og især refraktive forhold bliver belyst i den andet og tredje publikation. Det fjerde arbejde belyser risici for komplikationer under det kirurgiske indgreb. Postoperative komplikationer belyses i arbejde fem og seks. Endelig belyses den postoperative astigmatisme med forklarende variabler i delarbejde otte.

8.2. Indledning

Operation for katarakt (grå stær) er nu den almindeligste af alle elektive operationer i Skandinavien. Antallet af kataraktoperationer steg i Sverige fra 8000 i 1980 til 41009 i 1995. Det vil sige at knapt 5 ‰ af den svenske befolkning årligt opereres for grå stær. Udviklingen fra 1980 til 1990 kan ses i fig. 1. Det store antal operationer er af væsentlig samfundsøkonomisk betydning og nødvendiggør optimering af forhold vedrørende det operative indgreb. Perioden 1986 til 1990 omfatter 5878 konsekutive kataraktoperationer ved øjenklinikken i Lund. I 1990 bestod optageområdet af 382 811 indbyggere. Ingen anden klinik i optageområdet foretog kataraktoperationer i den pågældende periode. Patienter under 15 år var ikke inddraget i undersøgelsen da en stor del af børnene var henvist fra andre landsting. Øjenklinikken havde i 1992 ca. 31 000 ambulante besøg. Samme år blev der foretaget ca. 1400 kataraktoperationer.

8.3. Formål med undersøgelsen

Der er relativ få store populationsbaseret studier om kataraktkirurgi. Der er et stort behov for at belyse epidemiologiske forhold som køns- og alderssammensætningen i en stor kataraktpopulation. Der er publiceret et mindre antal studier om overlevelse hos kataraktpateinter, men de har ofte resulteret i forskellige konklusioner om mortalitet. Der er således et ønske om pålidelige mortalitetstal hvor konkurrerende sygdomme indgår. Parameterregistreringens detaljerigdom skabte mulighed for at belyse anatomiske forhold før det operative indgreb, samt undersøge forskellige faktorers indvirkning på hændelser under og efter operationen.

8.4. Metode

Materialet er indsamlet prospektivt og resultaterne baseret på alle kataraktoperationer i Lund fra 1986 til 1990. SPSS "Statistical Package for The Social Sciences" for Windows, der er en velegnet integreret programvare til statistisk bearbejdning af store datamaterialer blev anvendt.

8.4.1. Astigmatisme

Bygningsfejl i øjets hornhinde (asymmetri) angives som “med reglen” astigmatisme, hvis hornhindens mest brydende meridian ligger i intervallet 45° til 135°. Ved astigmatisme “mod reglen” er tilsvarende meridian placeret i intervallerne 0° til 45° eller 135 til 179. Bygningsfejl kan beskrives med to parametre, størrelse og retning. Det er ikke muligt uden at tabe information at konvertere disse to værdier til en. Det er dog en fordel ved forskellige statistiske beregninger at astigmatismen er udtrykt ved én størrelse. Den polære værdi $K_{pol}=M*(\sin^2\alpha-\cos^2\alpha)$ er en sådan. K_{pol} er hornhindens polære værdi i dioptrier og angiver størrelsen af “med reglen” astigmatismen. M er størrelsen af den totale hornhinde astigmatisme i dioptrier. α er hornhinde astigmatismens mest brydende meridian målt i grader. Ved induceret (hornhinde) astigmatisme menes forskellen mellem astigmatismen før og efter operationen.

8.4.2. Statistik

Af statistiske analyser blev anvendt parametriske såvel som non-parametriske metoder, simpel og multipel lineær regressionsanalyser samt kovariansanalyser. De mere komplekse værktøj som logistisk regression og Cox’s overlevelseanalyse modeller har ligeledes været anvendelige til resultatberegninger. Visse forhold mellem preoperative variable kunne bedst beskrives ved andengrads polynomier. Kaplan-Meier's grafiske illustrering er anvendt til analyse af forskelle i antallet af laserbehandlingen af efterstær mellem de to køn. Baggrundspopulationens dødelighed i regionen og primære dødsårsager har været anvendt til beregning af standardiseret mortalitets rater (SMR).

En p værdi < 0.05 blev betragtet som statistisk signifikant. Når sikkerhedsintervaller (konfidensintervaller) er angivet er det altid på 95% niveauet.

Dette studie er i mange henseender "cross-sectional" (en måling pr. individ). Dette gælder især de preoperative og kirurgiske registreringer. En del af de postoperative målinger og observationer er karakteristiske for en longitudinel studie, med flere målinger på samme individ på forskellige tidspunkter i forløbet. Begrebet "pseudo-longitudinel" vil sige at en parameter kun registreres en gang for hvert individ men målingerne anvendes til at beskrive ændringer med tiden (Altman 1995). Eksempel på dette er ændringen af øjets længde med alderen hvor længden af øjet og alderen er registret ved operationstidspunktet. Her skal man være ekstra påpasselig med tolkningen.

Det er let at ville applicere resultaterne, især de anatomiske, til normalpopulationen, men det må understreges at de angivne fund kun gælder for den beskrevne population indstillet til operation for grå stær i den pågældende periode.

8.5. Epidemiologi (I, VII)

Katarakt forekom hyppigere hos kvinder end hos mænd også når man tog højde for at kvinder levede længere. Gennemsnitsalderen ved det kirurgiske indgreb var uændret trods den kraftige stigning i operationsantallet, og derfor kan man ikke forvente en nedgang i operationsbehovet. Gennemsnitsoverlevelsen var efter operation for grå stær den samme som for baggrundsbefolkningen. Yngre kataraktpatienter havde en overdødelighed på grund af cirkulationsforstyrrelser. Desuden havde kataraktopereret patienter med diabetes, preoperativ makuladegeneration eller ledegigt en klar overdødelighed (Cox).

8.6. Iagttagelser før operation (II, III)

Det preoperative syn på det øje der skulle opereres steg i perioden 1986 til 1990.

Der var en lille overvægt af højre øjes operationer (53,4%).

Af andre øjenrelevante sygdomme havde en større del af mændene i kataraktpopulationen diabetes eller tidligere tilfælde af amotio retinae end kvinderne. Kvinderne havde hyppigere aldersrelateret makuladegeneration. Glaukom før operationen forekom i samme udstrækning hos begge køn.

I kataraktpopulationen havde 77.9% mindre end 1.5 dioptriers astigmatisme.

Kvinderne i kataraktgruppen havde i gennemsnit 0.4 mm kortere øjne samt 0.8 dioptrier kraftigere brydende hornhinde end mænd. Et øje der var 1 mm kortere havde i gennemsnit en hornhinde der var 0.4 dioptrier mere brydende.

Den planlagte postoperative refraktion gik fra -0.81 i 1986 til -0.23 i 1990. I gennemsnit planlagde man mindre myopi hos kvinden end hos manden.

Styrken på de implanterede kunstige linser var i gennemsnit 0.3 dioptrier større hos kvinder.

Mænd havde hyppigere "mod reglen" astigmatisme end kvinder, 56,5% versus 50,0%. "Med reglen" astigmatismen (Kpol) aftog i gennemsnit med 0.3 dioptrier når kataraktpatienten var 10 år ældre. "Med-reglen" astigmatismen (Kpol) aftog ligeledes med 0.3 dioptrier når det intraokulære tryk var 10 mm Hg højere. "Med reglen" astigmatismen (Kpol) var gennemsnitlig 0.07 dioptrier større på et øje der var 1 mm længere. Kvinder havde i alle de tre ovennævnte tilfælde en større "med reglen" astigmatisme.

Hornhindens totale astigmatisme uanset retning var mindst hos patienter med middellange øjne. Når et øje afveg fra "middellængden" var astigmatismen større. Sammenhængen kunne beskrives ved et andengrads polynom. Ligeledes kunne relationen mellem øjets længde og hornhindens totale brydning bedre beskrives ved et andengrads polynom i stedet for en ret linje.

Ældre patienter i kataraktgruppen havde gennemsnitligt mindre øjne end yngre. Forholdet mellem øjets længde og alder var således at en 10 år ældre patient havde et øje der i gennemsnitligt var 0.13 mm kortere (pseudo-longitudinal observation; se afsnit 8.4.2.). Hos mænd var øjet i gennemsnit 0.29 mm længere når øjetrykket var 10 mm Hg højere. Hos kvinder forholdt det sig omvendt proportionalt mellem disse to parametre; dog med mindre statistisk signifikans ($0.02<p<0.05$).

Mænd havde en hornhindebrydning der var 0,76 dioptrier svagere end kvinders. Hornhindens brydende kraft var gennemsnitligt 0.06 dioptrier svagere hos en 10 år yngre patient, der samtidig var ældre end 60 år ($0.02<p<0.05$). Når dette forhold blev undersøgt for alle aldre var der ingen sammenhæng for kvinder men stadigvæk for mænd.

Kvinder havde hyppigere "med reglen" astigmatisme (60°-120°) når hornhindeastigmatismer større end 0.5 dioptrier blev del op i 30 graders intervaller. Tilsvarende havde yngre aldersgrupper oftere "med reglen" astigmatisme end ældre aldersgrupper.

8.7. Iagttagelser under operation (IV)

Ruptur af den bagre linsekapsel under operationen med eller uden tab af glaslegeme blev benyttet som komplikationsindikator. Totalt fik 2.5% denne komplikation. Risikoen steg med en faktor 2.7 hvis patienten havde glaukom og en faktor 2.9 hvis kirurgen havde foretaget mindre end 40 operationer i hele perioden. Phakoemulsifiering(ultralydsmetoden), af katarakten med "lille-snit" blev introduceret i 1988. I 1990 steg risikoen med denne metoden med en faktor 3.7. Vi fandt i øvrigt ingen forskel mellem operationmetoderne for hele tidsrummet 1988 - 1990.

8.8. Iagttagelser efter operation (V, VI, VIII)

Nethindeløsning

Nethindeløsning er en alvorlig synstruende komplikation der 2 år efter det operative indgreb forekom hos 0.2% og efter 5 år hos ca. 0.4% af kataraktpatienterne. Et stort øjet samt laserbehandling af efterstær øgede den relative risiko for nethindeløsning med henholdsvis 1.3 pr. mm og 4.9. Med stigende operationsalder aftog risikoen for løsning af nethinden med en faktor 0.94 pr. år. Kønnet som eneste variabel i analysen viste at mænd havde en større risiko end kvinder for senere nethindeløsning. Kønnets påvirkning af risikoen for nethindeløsning forsvandt når de øvrige relevante forklarende variable var inkluderet i beregningsmodellen. Dette forklares bedst ved at mænd i kataraktpopulationen var yngre og havde længere øjne end kvinder.

Efterstær

Behandlingskrævende efterstær opstod hos mindst 50% af kvinderne og 40% af mændene. Disse procentsatser fremkommer når der tages hensyn til overlevelsen.

Kønsforskellen er stadig markant i overlevelses-analysen med de relevante variable. Mænd havde en mindre relativ risiko på 0.74 end kvinder for laserbehandling af efterstær.

Sphincterotomi foretaget under kataraktindgrebet resulterede med en faktor 0.73 i færre laserindgreb for efterstær. Forklaringen hertil kan være at undersøgende læge var mere opmærksom når patienten var belastet med anden øjensygdom udover katarakt og derfor i mindre udstrækning henviste for behandling af efterstær.

Med stigende patientalder vid operationen faldt behovet for efterstærsbehandling med en relativ risiko på 0.993 pr år dvs. 7% lavere risiko hos en 10 år ældre patient. Yngre personer udvikler hyppigere efterstær (Apple et al. 1992). En anden bidragende forklaring til lavere laserbehandlingshyppighed af efterstær hos ældre kunne være et mindre henvisningsbehov.

Jo senere i perioden 1986-1990 før kataraktindgrebet desto større risiko for YAG laserbehandling af efterstær. For hver måned der gik, steg risikoen for med en faktor 1.02. En stigning i dannelsen af uklarheder i linsekapslen eller et stigende ønske hos patient eller læge for efterstærsbehandling i perioden 1986-1990 kan forklare dette forhold. Der var en tendens til at patienter fra Lund oftere blev behandlet for efterstær end patienter fra mindre udpræget bysamfund som Orup og Ystad. Den relative risiko hos patienter fra Orup var henholdsvis 0.74 når patienter fra Lund var referencegruppe.

Astigmatisme

Efter kataraktoperationen var hornhinden oftest asymmetrisk med den stærkest brydende meridian i intervallet 45° - 135°, dvs. "med reglen" (Fig. 4). I dette arbejde angivet som den polære værdi Kpol.

En 10 år ældre patient havde i gennemsnit 0.4 dioptrier mindre "med reglen" astigmatisme (Kpol) dag 1 (dagen efter kataraktoperationen) og samtidig mindre ændring af hornhindeastigmatismen i den postoperative periode. Kønnet påvirkede ikke astigmatismen efter operationen.

En dioptri større preoperativ "med reglen"astigmatisme (Kpol) resulterede i 0.6 dioptris stigning i den postoperative Kpol (dag 1) og samtidig i en stejlere ændring af hornhindeastigmatismen i tiden efter operationen. En større preoperativ "med reglen" astigmatisme (Kpol) på en dioptri resulterede i 0.4 dioptriers mindre postoperative induceret astigmatisme (Kpol) dagen efter operationen (se 8.4.1.). Et preoperativ højere øjentryk på 10mm Hg resulterede i 0.7 dioptriers mindre postoperative "med reglen" astigmatisme (Kpol) dag 1 og mindre ændring af den postoperative astigmatisme pr. tidsenhed.

En stærkere hornhindebrydning preoperativt på en dioptri resulterede gennemsnitligt i 0.09 diopter mere "med reglen" astigmatisme (Kpol) dag 1. Horhindens brydning preoperativt havde ingen indflydelse på den postoperative hældningskoefficient for Kpol.

Hvis en sphincterotomi (radialt klip gennem iris) blev foretaget under operationen for katarakt var der 0.6 dioptriers mindre Kpol dagen efter og samtidig en mindre ændring af astigmatismen i den postoperative periode. Glaukomsygdom påvirkede de to astigmatisme variable i samme retning som sphincteromivariablen; men kun i den univariate regressionsanalyse var påvirkningen statistisk signifikant. Øjen alvorlig påvirket af glaukom samt øjne med andre konkurrerende sygdomme kan tænkes oftere at få udført iriskirurgi. Måske blev disse øjne håndteret kirurgisk anderledes med supplerende incision og manipulation der medfører mindre postoperativ astigmatism (Kpol).

Insulinbehandlet diabetes havde dag 1 0.7 dioptriers mindre Kpol og samtidig mindre ændring af Kpol i den efterfølgende periode. Hele diabetesgruppen påvirkede de to astigmatisme parametrer svagere i samme retning dog uden statistisk signifikans.

Phakoemulsifiering som operationstype resulterede i 2.2 dioptrier mindre "med reglen" astigmatisme dag 1, samt affladet hældning i ændring af astigmatismen. Et stort operationssnit (kl. 12) gav en mindre postoperativ "med reglen" astigmatisme mens et operationssnit i kornea gav det modsatte. Hvis snittet var med "scleral pocket" teknik opstod mindre "med reglen" astigmatisme (Kpol) dagen efter samt en mindre ændring af den postoperative astigmatisme pr. tid (corneoskleralt snit som reference).

Hvis der opstod kapsel/zonula ruptur med eller uden korpustab under kataraktindgrebet var "med reglen" astigmatismen 0.73 dioptrier (Kpol) mindre dagen efter og den postoperative astigmatismeudvikling pr. tidsenhed havde fladere hældning.

Der var bemærkelsesværdig stor forskel blandt de opererende læger når man analyserede variablerne for astigmatismen. Forskellene var højsignifikante mellem kirurger med samme beskrevet operationsteknik og samme operative erfaring. Det er kendt (Swinger 1987) at forhold som sutur længden og dybde ved lukning af operationssåret påvirker astigmatismen. Disse samt andre operationsdetaljer var ikke registreret.

Andre postoperative observationer

Hornhinden var mere brydende efter end før operationen henholdsvis 44.1 dioptrier og 43.9 dioptrier. Forskellen var højsignifikant men uden umiddelbar klinisk relevans. Det intraokulære tryk faldt fra 16.6 mm Hg før til 14.4 mm Hg efter operationen.

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