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Corneal topography parameters after superior clear corneal incision cataract surgery in arcus lipoides

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PURPOSE. *To compare changes in corneal topographic parameters after cataract surgery in eyes with different severities of arcus lipoides.*
METHODS. *Fourty eyes of 40 patients (23 women, 17 men, age 71.3±20.4 years, range 40 to 89 years) were studied prospectively in a consecutive, non-interventional, comparative series of cases. Eyes were classed in three groups (0 to 2) according to the assessed grade of arcus lipoides (none, <180°, >180°). Corneal topography (Tomey TMS-2) was performed preoperatively and at 1 and 10 days and 1 and 3 months following cataract surgery (superior 4.0 mm clear corneal incision, no suture). Keratometric astigmatism (Dcyl), surface regularity index (SRI), surface asymmetry index (SAI), and potential visual acuity (PVA) were evaluated for the different groups and time-points, using the Kruskal-Wallis, Wilcoxon, and Mann-Whitney statistical tests.*
RESULTS. *No significant preoperative difference was found in mean Dcyl, SRI, or PVA; preoperative SAI was lower in Group 1. Postoperatively Dcyl was increased at day 1 in Groups 1 and 2, and remained higher in Group 2 until month 1. At month 3 significant differences among Groups 0, 1, and 2 disappeared.*
CONCLUSIONS. *The 4.0 mm superior clear corneal incision is a safe method for cataract surgery in the presence of arcus lipoides. This procedure induces greater corneal astigmatism, surface irregularity, and lower PVA in the early postoperative period in cases with arcus lipoides than in normal corneas. Concerning final results, wound healing was not affected by greater severity of arcus lipoides, although stabilization of the corneal surface tended to be slower. (Eur J Ophthalmol 2006; 16: 24-9)*

KEY WORDS. *Arcus lipoides, Arcus senilis, Corneal arcus, Corneal incision, Corneal topography*

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INTRODUCTION

Surgically induced astigmatism (SIA) occurs as a consequence of all types of cataract surgery. The grade, cylinder axis, and time course of SIA depend on numerous factors such as the incision method (1), length (2), and shape of incision (1), location and distance of the incision from the corneal center, and its site (corneal or sclerocorneal incision) and angular position (e.g., superior, temporal, nasal, superonasal). A small, superior clear corneal incision has been reported to induce the least amount of SIA (3).

Corneal degenerations, by affecting the corneal extracellular matrix architecture, can influence wound healing and corneal topographic measurements after cataract surgery (4, 5). In this study we investigate a possible link between SIA and the presence of arcus lipoides corneae (also called corneal arcus and arcus senilis), which is a common bilateral degenerative disorder associated with aging. All names of this disor-

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der cover identical clinical features and pathology: clinically visible cream-colored ring-shaped corneal opacities are present, caused by excessive lipoid deposits in the corneal stroma.

Small changes in the surface topography can adversely affect visual acuity. Corneal topography is an accurate and reproducible technique (6), which measures the radius of the cornea and the corneal refractive power (and can reveal the amount of SIA). Additional parameters, corresponding to the regularity (surface regularity index [SRI]) and the asymmetry (surface asymmetry index [SAI]) of the corneal surface, and the calculated potential visual acuity (PVA) provide a more detailed evaluation of the corneal surface (7, 8).

The SRI and SAI indices increase as the corneal surface departs from the ideal smooth surface and spherical form. The SRI is a measure of the central corneal optical quality; the more regular the surface, the lower the SRI value. Similarly, the more symmetric the contour of the whole surface, the lower the SAI value. The PVA figure is calculated by the instrument from the topographic values, and is intended to approximate the conventionally measured decimal VA figure (nominally 1.0 for normal eyes); the better the topographic values, the higher the PVA.

The aim of this study was to follow-up the course of corneal wound healing (as reflected in the measured values) after superior clear corneal incision cataract surgery in normal eyes and eyes with various different grades of arcus lipoides, and to investigate the potential effects of corneal arcus on the postoperative corneal topography.

METHODS

Design and patient population. This was a prospective single-center study (consecutive, non-interventional, comparative series of cases) carried out on 40 eyes of 40 patients (23 women, 17 men, age 71.3 ± 20.4 years, range 40 to 89 years) who underwent uneventful phacoemulsification and posterior chamber lens implantation in our clinic between September 2003 and May 2004. Patients who had any ocular surface pathology apart from arcus lipoides were excluded. None of the patients wore contact lenses.

Grading of arcus lipoids. The severity of arcus lipoides was evaluated during a slit-lamp examination carried out preoperatively. Grading was semi-quantitative on a scale from 0 to 2, according to the circumferential extent of lipoid deposition in the corneal stroma, as published in the Blue Mountain Eye Study (9). Grade 0 (n=6, mean age: 56.3±4.8) indicates no visible presence of arcus; grade 1 (n=18, mean age: 70.1±12.0) was assigned when arcus lipoides was present in <180°; grade 2 (n=16, mean age: 71.9±7.4) was assigned when >180°. Patient age was significantly younger in Group 0 compared to Groups 1 and 2.

Corneal topography and follow-up. Besides detailed ophthalmologic examination, corneal topography was performed on both eyes with the TMS-2 corneal topograph (Tomey GmbH, Erlangen, Germany). The first such examination was done on the day prior to surgery. Postoperative corneal topography was carried out on postoperative day 1, day 10, and after 1 and 3 months. On each occasion the images used for calculations were recorded at a standard interval (5 seconds) after a complete blink, to minimize the influence of topographic alterations caused by postblink tear-film changes (7, 10). No eye drops were applied within 1 hour prior to the corneal topography measurements. All 40 patients were examined during the preoperative visit. However, no evaluable topographic image could be obtained for four eyes (one in Group 1 and three in Group 2); the reasons were in one case poor patient compliance, and in the others inadequate fixation caused by a non cornea-related abnormality (macular degeneration, dense cataract, amblyopia). In addition, on the first postoperative day in four cases no evaluable image was possible because of postoperative photosensitivity or pain; and on later occasions some patients failed to attend. The number of evaluable eyes for each visit (preoperative, day 1, day 10, month 1, month 3) were the following, respectively: grade 0 (6, 4, 4, 4, 3), grade 1 (17, 14, 11, 14, 11), and grade 2 (13, 11, 5, 9, 6).

Surgical procedure. All operations were carried out by the same surgeon (M.B.) using the same technique. After retrobulbar anesthesia a 3.2 mm clear corneal incision was performed in two steps with a bevel-up disposable steel blade at the anterior edge of the limbal vessel (peripheral to arcus), at the 12 o'clock position. After this, a lamellar 1.5 mm dissection was made at the 3 o'clock position. After phacoemulsification and cortex removal the 3.2 mm wound was enlarged to 4.0 mm using the same type of blade. A hy-

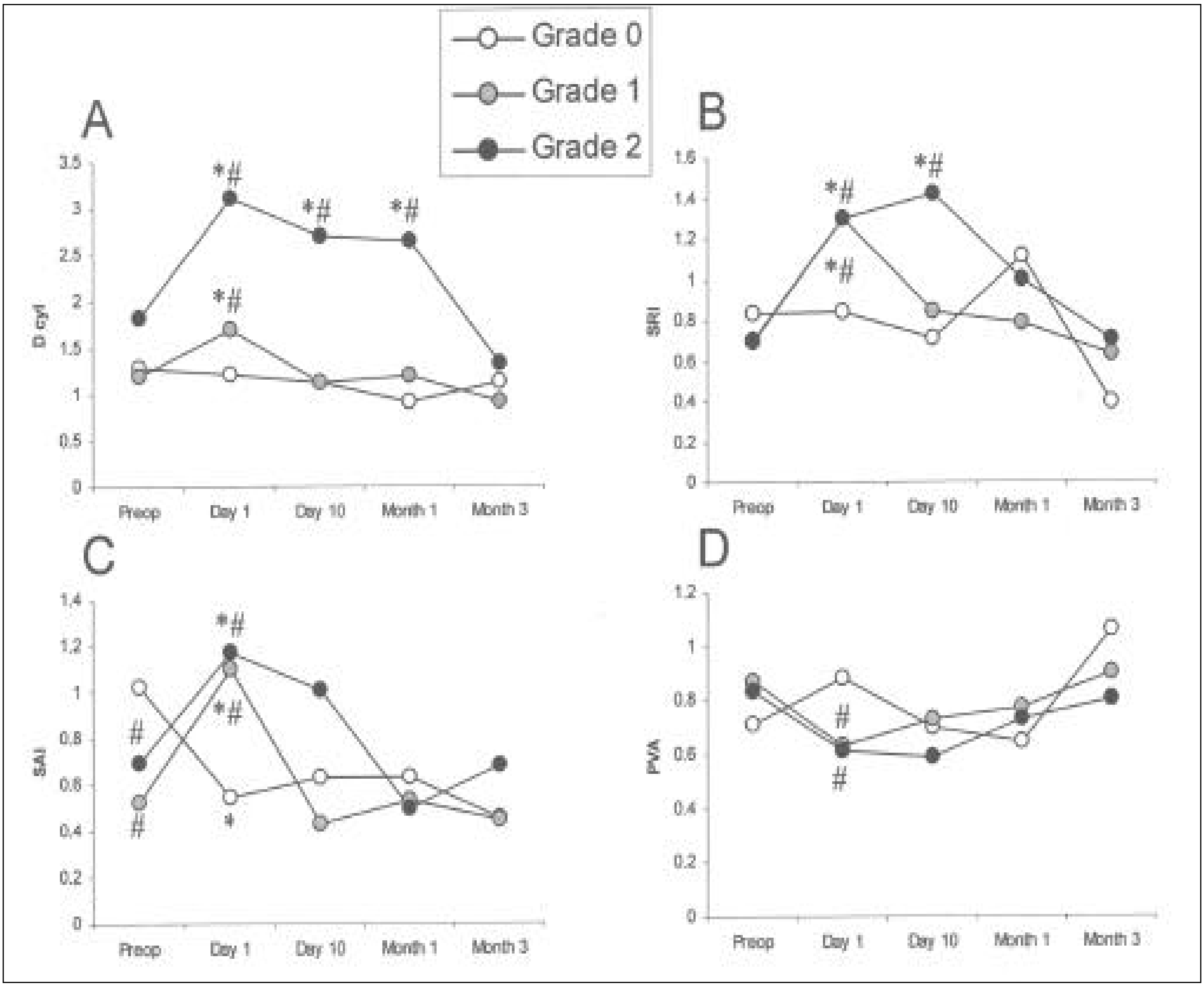

Fig. 1 - *Graphs showing the time course of corneal topographic results (mean values):* **(A)** *keratometric astigmatism (Dcyl);* **(B)** *surface regularity index (SRI);* **(C)** *surface asymmetry index (SAI);* **(D)** *potential visual acuity (PVA). Note the significant difference in Dcyl. Preoperative values are not different; difference disappears at day 10 in Group 1 and only at month 3 in Group 2. The slower stabilization of SRI values in Group 2 are shown. The preoperative SAI was different both in Group 1 and Group 2. The PVA curves are almost identical compared to the other topographic parameters. *Significant difference from preoperative value (p<0.05, Wilcoxon test). #Significant difference from Group 0 (p<0.05, Mann-Whitney test).*

drophobic acrylic foldable posterior chamber lens was then implanted with forceps in the capsular bag. During surgery, 10 mg/mL sodium hyaluronate (ProVisc) was used as viscoelastic material. No suture was used. Prednisolone acetate eye drops were given five times daily for the first 2 weeks, reduced to three times daily for the following 2 weeks.

Main outcome measures. The keratometric astigmatism in diopters (Dcyl) was calculated by the computer from the simulated keratometric (Sim K) values. The SRI, SAI, and PVA values were recorded at each visit.

Data were analyzed statistically using the Wilcoxon test, and the Mann-Whitney *U* test, using the SPSS analysis package (version 10.0 for Windows; SPSS Inc., Chicago, IL).

Differences were regarded as significant for $p<0.05$ (confidence interval 95%).

RESULTS

The topographic parameters are listed below. No significant difference was found between Groups 0–1 and 0–2 at the preoperative visit (Mann-Whitney *U* test) in Dcyl, SRI, or PVA cornea topographic parameters. The postoperative time-course of the mean values is shown in Figure 1 for each parameter separately.

Corneal astigmatism (Dcyl) did not show any change during the follow-up in Group 0. In Groups 1, 2, and 3 the postoperative cylindric diopter was significantly different at different time points, showing moderate fluctuation. It was higher compared to preoperative value (Wilcoxon test) in Group 1 at day 1 ($p=0.02$) and in Group 2 at day 1 ($p<0.01$), at day 10 ($p<0.01$), and at month 1 ($p=0.01$). Among groups astigmatism was higher in Groups 1 ($p=0.03$) and 2 ($p=0.01$) compared to Group 0 (Wilcoxon test) throughout the follow-up period (Fig. IA).

Surface regularity was poorer (higher SRI) in Groups 1 ($p=0.04$) and 2 ($p=0.01$) compared to Group 0 at postoperative day 1 (Fig. 1B). The SRI remained higher in Group 2 at day 10, but the significant difference disappeared in Group 1 at day 10. In all groups SRI fluctuated, but stabilized by month 3.

Surface asymmetry (SAI) was higher in Group 1 ($p=0.05$) and Group 2 ($p=0.04$) compared to Group 0 (Mann-Whitney) preoperatively. It showed greater fluctuations than the other parameters (Fig. 1C).

PVA in Groups 1 and 2 was lower than in Group 0 at day 1. Otherwise the curves did not show any differences between groups (Fig. 1D).

DISCUSSION

Arcus lipoides is not a debilitating disease of the cornea, but is very often present in the population undergoing cataract surgery. We supposed that lipid deposition into the cornea – in analogue to the arterial walls – can change the rigidity of the structure, which might influence the topographic parameters of the cornea. Phacoemulsification induces SIA, which occurs in healthy corneas and corneas with arcus lipoides as well.

The age-discrepancy between Group 0 and the other groups can be explained by the increased frequency of arcus lipoides with age (it was not possible to study patients with different grades of corneal arcus but of similar ages). Moss et al in a cohort study (11) found arcus lipoides in 53.8% of men and 48.5% of women between age 30 and 80. Chua et al (9) reported – as a part of the Blue Mountains Eye Study – that arcus lipoides was positively correlated (a linear increase of prevalence) with age, and was more frequent in men. They used a three-stage grading of arcus lipoides: no arcus; partial (<180 degrees); and circumferential (>180 degrees). For our patients with more severe arcus lipoides, the general systemic status (not examined) was probably worse than for the patients of younger average age in Group 0.

Although no long-term characteristic changes were noted in the corneal topographic parameters, the early postoperative fluctuations observed suggest that arcus lipoides may cause slight irregularity of the corneal wound healing after a clear corneal incision. The fluctuation of the keratometric astigmatism seems to show most clearly the transient postoperative instability of the cornea, which was present in the higher grade of arcus lipoides. A complex of several factors can assist in explaining our results.

Size of incision, sutures. In our previously presented case report (4), extracapsular cataract excision was performed on an eye with severe arcus lipoides using a long (9 mm) sclerocorneal incision. With use of a clear corneal incision, the possible impact of arcus lipoides on the delayed wound healing is minimized compared to the larger corneoscleral wound with sutures. In addition the clear corneal lamellar incision was created in a way that it entered the cornea peripheral to the arcus lipoides and entered the anterior chamber central to the corneal arcus. Merriam et al (3) compared six types of cataract incisions different in size and location, and reported that after a 3 mm superior sutureless clear corneal incision the corneal meridians stabilize in 0.3 months, whereas after extracapsular cataract excision with use of running suture stabilization takes 4.5 months. It has been found that a single radial suture can alter the astigmatism (12). Barequet et al found in a retrospective study (13) that SIA is still evident at 6 weeks, and persisted for up to 12 months postoperatively. A long corneoscleral incision with running suture results not only in higher SIA; the SAI and SRI parameters are also worsened. Our results up to 3 months are similar to those of the Auckland Cataract Study (14), which included a 2-year postoperative assessment of topographic changes.

Localization of lipoid degeneration and examination method. Corneal topography images originate from the anterior surface of the cornea. In corneal arcus, the lipoid deposition is localized in the stroma (15, 16). The changes of corneal wound healing take place in the stroma, and are not always reflected in the corneal topography. The actual stromal changes can be visualized and measured using complex topography and pachymetry systems (17), which provide images of the anterior and posterior surface and pachymetric data simultaneously.

Tear film. The tear film is influenced by reaction to the surgical intervention and by the regular postoperative use of eye drops (10), and can mask the true changes of the corneal surface. The SRI and SAI values quantify the surface characteristics of the corneal topography. This is an additional reason why the indices for the surface may not accurately represent the changes of the deeper stromal extracellular matrix (ECM).

Grading of arcus lipoides. The grading system employed might have limitations, because corneal arcus usually starts in the limbus area under the superior eyelid, the very location where the incision was made. Thus, higher grade of arcus lipoides might represent no additional risk during the stromal and superficial remodeling of the cornea.

We conclude, however, that the 4.0 mm superior clear corneal cataract incision is a safe method for cataract surgery in arcus lipoides. Such a procedure does not appear to induce more corneal astigmatism, surface irregularity, or surface asymmetry in eyes with arcus lipoides as compared to normal corneas. The wound healing at 3 months was independent of the grade of arcus lipoides in respect of corneal topographic results, although the corneal surface stabilised slower in arcus lipoides.

None of the authors has any commercial or proprietary interest in any product mentioned in this study.

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