THE EFFECT OF TORIC MULTIFOCAL LENS ROTATION ON VISUAL QUALITY

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SUMMARY
THE EFFECT OF MULTIFOCAL TORIC LENS ROTATION ON VISUAL QUALITY

Purpose: The aim of the study was evaluation and comparison of rotational stability and the effect of multifocal toric intraocular lens rotation (T-MIOL) at visual quality of two types of intraocular lens AcrySof IQ ReSTOR Toric SND1Tx (Alcon Laboratories, Inc.) and AT LISA toric 909M (Carl Zeiss Meditec AG). There was evaluated a pseudophakic dysphotopsia based on patient's subjective feelings as well as the independence on glasses and overall satisfaction with the visual quality after T-MIOLs were implanted.

Methods: The retrospective study included 68 eyes (100 %) of 34 patients, who underwent an uncomplicated cataract surgery with multifocal toric intraocular lens was implanted. 68 eyes were divided into two groups. Group A consisted of 48 eyes (70,6 %) with AcrySof IQ ReSTOR Toric SND1Tx and group B included 20 eyes (29,4 %) with AT LISA toric 909M multifocal toric intraocular lenses were implanted. The T-MIOL position, planned axis and misalignment were evaluated one week and 6 months after surgery. Surgical lens reposition was indicated in case of worsening visual quality due to T-MIOL rotation from its planned position.

Results: In the group of 68 eyes, the mean uncorrected distance visual acuity (UDVA) before surgery was 0,08 (n = 48) in group A and 0,09 (n = 20) in group B. The mean UDVA after T-MIOL were implanted improved to 0,83 ± 0,06 (n = 48) in group A and 0,75 ± 0,08 (n = 20) in group B. The mean UDVA in patients before T-MIOL surgical rotation was 0,57 ± 0,03 (n = 5) in group A and 0,59 ± 0,08 (n = 5) in group B. At six months after T-MIOL surgical rotation, the uncorrected distance visual acuity was 1,0 in both groups (p = 0.70). The surgical rotation of T MIOL was performed in 10 eyes (14,7 %) of 68 eyes (p = 0.48), in group A (n = 48) in 5 eyes (10,4 %) and in group B (n = 20) in 5 eyes (25,0 %). Mean deviation from the planned axis was 8,2 ± 1,78 degrees in group A and 13,4 ± 3,04 degrees in group B. At six months postoperatively, the T-MIOL rotational stability showed less than 5 degrees for all surgically rotated lenses in both groups. Mean cylinder decreased in all patients from -2,92 ± 1,85Dcyl to -0.85 ± 0.61Dcyl after surgery. The mean spherical equivalent for all patients decreased from 0,56 ± 4,75D to 0,06 ± 1,33D after surgery. Presence of disturbing fotic phenomenon had reported 11 (32.4 %) of 34 patients, 9 of them they were subsequently indicated T-MIOL reposition. All 34 patients were able to perform normal daily tasks independently on spectacle correction. At six months after surgery, there was very high satisfaction with the quality of postoperative vision in both groups.

Conclusion: Implantation of toric multifocal intraocular lens, both of AcrySof ReSTOR Toric SND1Tx (Alcon Laboratories, Inc.) and AT LISA toric 909M (Zeiss Meditec AG Carl) in cataract patients is safe and effective method to correct corneal astigmatism and maintain the visual multifocality. Early surgical T-MIOL reposition should be performed to put the T-MIOL to planned axis in steepest meridian if unwanted lens rotation is identified.

Key words: cataract surgery, toric multifocal intraocular lens, rotation, rotational stability, quality of vision

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INTRODUCTION

At present, cataract surgery with the implantation of a toric multifocal intraocular lens (T-MIOL) ranks among relatively common refractive intraocular procedures. The increasing number of performed operations and a shift in the age of the operated patients in a direction towards younger age groups is placing ever greater emphasis on the final result of the operation, above all in the sense of minimal postoperative refractive error. The increasing demands of patients for postoperative vision without dependence on correction by glasses require a simultaneous correction of not only spherical but also astigmatic defect.

Astigmatism is a frequent refractive error. Its incidence is estimated at as high as in 95% of the population. A small degree of astigmatism (0.25 D) occurs in practically all individuals. Astigmatism larger than 1.0 D occurs in approximately 20% of the population, and larger than 2.0 D in 5-10%. In patients with a cataract, the incidence of astigmatism larger than 1.5 D is stated in 15 to 29% of the population (10, 12).

In accordance with changing lifestyles and the prolonging of the active life of the population, patients after cataract

surgery expect fully fledged uncorrected vision at all distances and are ever increasingly requesting multifocal implants. However, in patients with a multifocal lens, the presence of preoperative corneal astigmatism can substantially reduce the quality of vision and lead to postoperative dissatisfaction. The surgeon must therefore choose a method and technique of the operation which is optimal for the patient both with regard to treatment of cataract and from the perspective of management of preoperative astigmatism (1).

There are several possibilities for surgical correction of astigmatism: from the simple positioning of the surgical incision in the place of the steepest corneal meridian to the incision and laser techniques. One of the the simplest but least effective incision techniques is the positioning of the surgical incision in the place of the steepest corneal meridian. More effective are astigmatic keratotomies. However, difficult predictability, relatively frequent regression and limited effectiveness in the case of incision techniques somewhat restrict their indication spectrum. Correction of astigmatism using laser techniques is precise in comparison with incision techniques, and the final result is well predictable. A certain disadvantage lies in the fact that the solution consists of two separate steps – cataract surgery and laser correction of astigmatism (1, 9).

An appropriate solution for patients with preoperative corneal astigmatism who at the same time wish to be free of dependence on correction with glasses at all distances appears to be modern multifocal implants with a toric component. An indisputable advantage of the implantation of toric multifocal implants is that in patients with cataracts this simultaneously resolves the removal of the cataract, correction of spherical and astigmatic errors and brings about multifocal vision in a single step. A disadvantage of T-MIOLs can be considered to be the risk of their postoperative rotation with a subsequent negative influence on quality of vision and the presence of disruptive photic phenomena.

The aim of the study is to evaluate and compare rotational stability and the influence of rotation of toric multifocal intraocular lenses on quality of vision in two types of intraocular lenses, namely AcrySof IQ ReSTOR Toric SND1Tx (Alcon Laboratories, Inc.) and AT LISA toric 909M (Carl Zeiss Meditec AG). On the basis of patients' subjective feelings, the study evaluates the presence of pseudophakic disphotopsia with a focus on obtrusive, disruptive photic phenomena, as well as patients' independence of glasses correction and overall satisfaction with quality of vision following implantation of the T-MIOL.

METHOD

In a retrospective study we focused on an evaluation of surgical rotation following the implantation of two types of toric multifocal intraocular lenses. This concerned the toric multifocal intraocular lenses AcrySof IQ ReSTOR Toric SND1Tx (Alcon Laboratories, Inc.) and single-piece toric multifocal lenses AT LISA toric 909M (Carl Zeiss Meditec AG).

The lens AcrySof IQ ReSTOR Toric SND1Tx is a single-piece lens with biconvex optics and an apodized diffraction zone with addition of +3D on the anterior surface of the optical component, and with a toric component on the posterior surface of the optics. The diameter of the optical part is 6.0 mm, the total length of the lens is 13.0 mm. The lens with a refractive index of 1.55 is produced from acrylate/methacrylate copolymer and is furnished with a filter for UV radiation and for high-energy blue light. The modified "L" haptics have zero angulation (fig. 1). The lens is available in dioptric strength from +6.0 to +30.0 D in intervals of 0.5 D. The models SND1T2, T3, T4 and T5 correct regular corneal astigmatism from 0.68 to 2.06 D.

The lens AT LISA toric 909M is a single-piece, aspherical, multifocal lens with 6.0 mm biconvex fully diffraction optics addition of +3.75 D and total length of lens 11.0 mm. It is produced from hydrophilic acrylate with 25% water content and a refractive index of 1.46. This concerns a lens with a "plate haptic design", with four haptics with zero angulation. The anterior surface of the lens is formed by a toric component and the posterior surface of the intraocular lens consists of multifocal aspherical diffraction optics (fig. 2). It is available in a dioptric range form -10.0 to +32.0 D (in intervals of 0.5 D) and cylindrical strength from +1.0 to 12.0 D.

The study included a total of 68 eyes (100%) of 34 patients, of whom 19 were men and 15 women, aged from 49 to 68 years (average age 57.48 ± 7.45 years), in whom uncomplicated cataract surgery was performed with implantation of a toric multifocal lens into the sac. In all cases this concerned eyes with regular astigmatism without other corneal, retinal or uveal pathology. We indicated a T-MIOL for patients with regular corneal astigmatism larger than 1.0 and smaller than 8.0 (mean 2.92 ± 1.85 D). Spherical equivalent before surgery was 0.56 ± 4.75. For correction of corneal astigmatism up to 2.0 D we used the lens AcrySof IQ ReStor Toric in models T2-T5. In the case of a value of corneal astigmatism higher than 2.0 cylindrical dioptres we chose implantation of AT LISA toric 909M. In all patients the T-MIOL was implanted into both eyes, at an interval of up to 14 days.

We divided the cohort of eyes into two groups. The first group A comprises 48 eyes (70.6%) of a total of 24 patients with a toric multifocal lens AcrySof IQ ReSTOR Toric SND1Tx. The second group B included 20 eyes (29.4%) of 10 patients with an implanted toric multifocal intraocular lens AT LISA toric 909M.

Preoperatively the patients underwent a complete eye examination, including corneal topography, keratormetry, refractometry, tonometry, biomicroscopy and ophthalmoscopy in artificial mydriasis. Measurement of the axial length was conducted on an instrument Zeiss Humphrey IOL Master (Carl Zeiss Meditec AG). The values of keratometry and axes of astigmatism were obtained with the help of optical biometry (IOL Master, Carl Zeiss Meditec AG) and corneal topography on the basis of Scheimpflug imaging (Pentacam HR, Oculus Optikgeräte GmbH). We performed the calculation of the dioptric strength of the lens with determination of the T-MIOL model online with the help of a special program recommended by the lens manufacturer (www.acrysoftoric-calculator.com, www.meditec.zeiss.com/iolmaster-online). The type and model of the lens was determined on the basis of preoperative keratometry, the biometric data, determination of the positioning of the surgical incision and the values of surgically induced corneal astigmatism, with statement

of the spherical equivalent of the lens, the cylindrical value and the axis of positioning of the T-MIOL in the eye. For calculation of the spherical equivalent of the lens we used the formula SRK/T. Examination of visual acuity was performed naturally and with glasses correction on Snellen's optotypes, the results of the examination are stated in decimal values on Snellen's rows. Subjectively perceived presence of pseudophakic dysphotopsia – positive (halo, glare) and negative (dark curved shadow in temporal part of visual field) and the disruptive character of photic phenomena was determined in patients and follow-up examinations. In the sixth month after surgery patient satisfaction with the result of the operation and dependency of patients on glasses correction for distance vision, for middle distance and close-up vision was determined in the form of a questionnaire. Overall patient satisfaction with the result of the operation was evaluated on the basis of subjective statements from the patients as: Satisfied, Rather Satisfied, Rather Dissatisfied and Dissatisfied.

The operation was performed by a total of three qualified surgeons. In all cases continuous circular capsulorhexis, standard phacoemulsification, irrigation/aspiration of the cortex and implantation of the T-MIOL into the sac with rotation to the required axis was performed under topical anaesthesia by means of a temporally positioned corneal incision with a size of 2.2 mm, using an ophthalmic viscosurgical device (OVD).

We performed marking of the axis for correct orientation of the T-MIOL in the eye on the operated eye in the sitting position due to potential cyclotorsion in a lying position with a subsequent undesirable impact on the precision of marking of the axis. We marked the horizontal and vertical axis (referential points at 3, 9, 6 and 12 points on the clock) on a slit lamp using a special marker by the corneal limbus, and at the same time we marked the axis in which the T-MIOL is to be oriented. On the operating table we performed an examination of the accuracy of marking the axis for positioning of the T-MIOL on patients in a lying position using a Cionni corneal marker. The OVD was thoroughly removed from the eye, including retrolentally. The surgical incision was closed by hydration of the corneal stroma without the use of suturing.

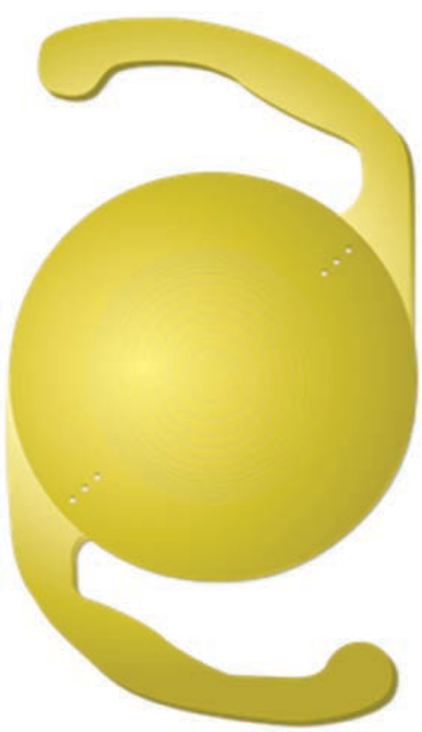

Fig. 1 toric multifocal intraocular lens AcrySof IQ ReSTOR Toric SND1Tx (Alcon Laboratories, Inc.)

Fig. 2 toric multifocal intraocular lens AT LISA toric 909M (Carl Zeiss Meditec AG)

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We performed a follow-up examination on the first day, one week, one month and six months after the operation. We conducted an examination of uncorrected and corrected visual acuity for distance vision and close-up vision, keratometry, refractometry, tonometry, biomicroscopic examination of the anterior segment and ophthalmoscopy. An examination of the positioning and orientation of the axis of the toric multifocal intraocular lens and an evaluation of any applicable rotation was performed on a slit lamp furnished with a scale in artificial mydriasis always one week after the surgical procedure. In the case of deviation of the T-MIOL from its planned position, surgical repositioning of the lens was indicated. Repositioning was performed under topical anaesthesia and consisted of rotation of the lens to the required axis. Rotation of the T-MIOL was performed within the shortest possible time after primary implantation (mostly from the 7th to 10th day). In certain cases rotation was performed later due to personal reasons and requests from the patient, no longer than after an interval of one month following primary implantation of the lens. The observation period of rotation stability in patients who underwent surgical rotation of the T-MIOL was six months from repositioning.

The preoperative and postoperative data was evaluated using the statistical program NCSS 9. The data is presented in the tables using the mean value. A bar chart with deviations was used for the graphic presentation. A dual selection t-test was used for the comparison of both types of operations and their influence. The stipulated level of significance was $P < 0.05$.

RESULTS

In our cohort of 68 eyes, mean Uncorrected Distance Visual Acuity (UDVA) before surgery in was 0.08 in group A (n = 48)

and 0.09 in group B (n = 20). Mean UDVA after implantation of a T-MIOL in group A improved to 0.83 ± 0.06 (n = 48) and in group B to 0.75 ± 0.08 (n = 20). In patients before surgical rotation of the T-MIOL, mean uncorrected distance visual acuity (UDVA) in group A was 0.57 ± 0.03 (n = 5) and in group B 0.59 ± 0.08 (n = 5). Six months after surgical rotation, uncorrected distance visual acuity was 1.0 in both groups (p = 0.70) (graph 1). The spherical equivalent of 0.56 ± 4.75 D before surgery improved to 0,06 ± 1.33 D after surgery (n = 68).

Of the total number of 68 eyes (100%), surgical rotation of the toric multifocal intraocular lens was performed in 10 eyes (14.7%) (p = 0.48). In group A surgical rotation was performed in 5 eyes (10.4%) and in group B in 5 eyes (25.0%) (graph 2).

The mean deviation from the planned axis was 8.2 ± 1.78 degrees in group A (n = 5) and 13.4 ± 3.04 degrees in group B (n = 5). The mean deviation in both groups was 10.8 ± 2.41 degrees (p = 0.01) (graph 3).

After implantation of the toric multifocal intraocular lens there was an improvement of uncorrected visual acuity from 0.08 ± 0.06 before surgery to 0.58 ± 0.06 after surgery. The mean residual refraction before surgical rotation of the toric multifocal intraocular lens in group A (n = 5) was +0.25 Dsf – 1.25 Dcyl and the mean best corrected distance visual acuity (CDVA) with glasses correction was 0.92 ± 0.05. Six months after the performance of surgical rotation of the T-MIOL, residual refraction was +0.25 Dsf – 0.50 Dcyl and mean uncorrected distance visual acuity (UDVA) in group A was 1.0.

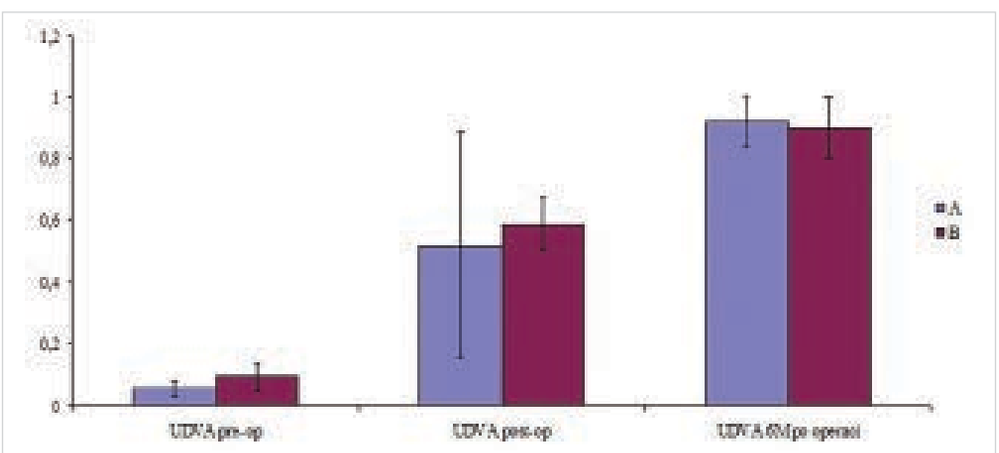
In group B (n = 5) there was an improvement of uncorrected visual acuity from 0.09 ± 0.09 before surgery to 0.59 ± 0.08 after surgery, residual refraction before surgical rotation of the toric multifocal intraocular lens was +0.50 Dsf – 2.00 Dcyl and mean best corrected distance visual acuity (CDVA) was 0.89 ± 0.08. Six months after surgical rotation of the T-MIOL, residual refraction was +0.25 Dsf – 0.75 Dcyl and mean uncorrected distance visual acuity (UDVA) in group B was 1.0 (table 1).

Pseudophykic dysphotopsia was perceived by all patients (n = 34) one week after surgery. In all cases this concerned positive pseudophakic dysphotopsia (halo, glare), we did not record negative dysphotopsia in any of the patients. A total of 11 patients (32.4%) stated that pseudophakic dysphotopsia was disruptive, in nine cases these were patients who were subsequently indicated for repositioning of the T-MIOL. Disruptive photic phenomena disappeared either completely or partially in all of the patients immediately after rotation of the T-MIOL. At a follow-up examination in the first month after surgery, only 3 (8.8%) patients (2 from group A, 1 from group B) of a total number of 34 stated disruptive photic phenomena. In the sixth month after the procedure none of the patients perceived a disruptive character of photic phenomena.

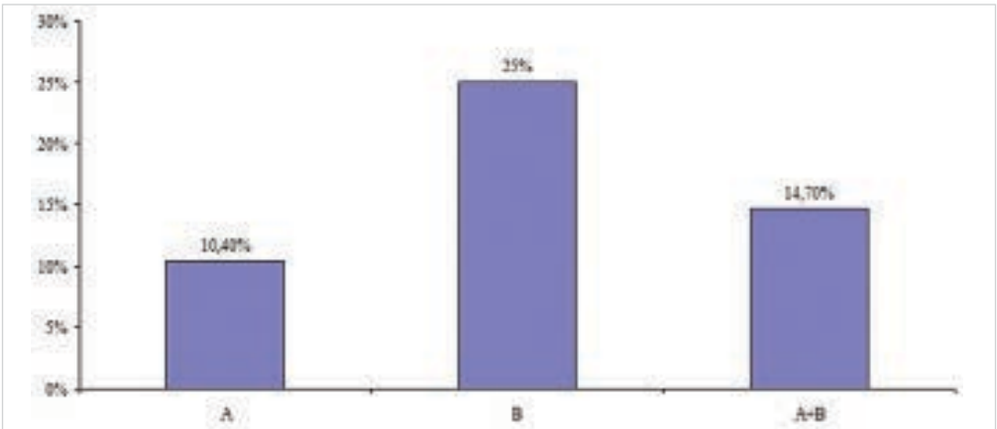
All 34 (100%) patients were able to perform regular daily tasks without dependence on glasses correction. Two patients (5.9%) (1 from group A and 1 from group B) occasionally used glasses during close-up work of a longer duration. These patients stated that vision with glasses correction was more comfortable. A total of 29 patients (85.3%) stated satisfaction with postoperative quality of vision six months after surgery, 5 patients (14.7%) were rather satisfied (3 from group A and 2 from group B). No patients were rather dissatisfied or dissatisfied.

DISCUSSION

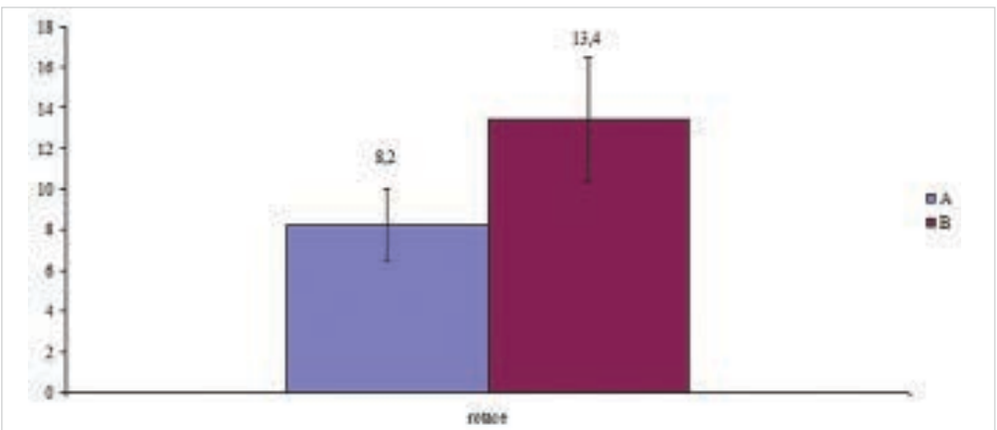
There are fundamentally less patients who are suitable for implantation of the toric variant of a multifocal intraocular lens (T-MIOL) than patients suitable for implantation of a conventional multifocal lens (MIOL). The main indication for implantation of a toric multifocal lens is the patient's desire to be independent of correction with glasses at all distances. Upon indication of a T-MIOL it is necessary to take into account not only the ocular finding and visual preference, but also the patient's personality type, profession and out of work activities. In general toric multifocal intraocular lenses are recommended for patients with minimal ocular comorbidity. For example, eyes with irregular corneal astigmatism, affliction of the cornea, disease of the retina or macular degeneration are considered unsuitable for implantation of a T-



Graph 1 Uncorrected distance visual acuity in decimal values of Snellen's rows in group A (n = 5, 10.4%) and group B (n = 5, 25.0%) before primary implantation of a T-MIOL, before surgical rotation and 6 months after surgical rotation (p = 0.70)



Graph 2 Percentage representation of T-MIOL indicated for surgical rotation in group A (n = 5, 10.4%), group B (n = 5, 25.0%), in both groups A + B (n = 10, 14.7%) (p = 0.48)



Graph 3 Mean deviation from planned axis in degrees in group A (n = 5; 8.2°) and group B (n = 5; 13.4°) (p = 0.01)

MIOL. We must exercise caution in the case of patients with glaucoma and dry eye syndrome. The suitability of implantation of a T-MIOL into an eye following a previous surgical or laser refractive procedure is contentious.

In the planning of a surgical solution it is essential to include careful preoperative "chair time", with education of the patient concerning the advantages and disadvantages of a T-MIOL and instruction on the postoperative regime and course of healing. In our cohort, the indication criteria for implantation of a toric multifocal intraocular lens included among other factors above all regular corneal astigmatism and uncomplicated surgery with implantation of a T-MIOL into the lens capsule. A key role for the selection of the type of implanted T-MIOL was played by the patient's stated preferences with

Table 1 Summary table of observed parameters before primary implantation of T-MIOL, one week after surgery, before surgical rotation and 6 months after performance of surgical rotation

		Total A+B	Group A	Group B
Number (n)		10	5	5
UDVA	pre - op	0,09?0,06	0,08 ± 0,03	0,09 ± 0,09
	1T post - op	0,58 ± 0,06	0,57 ± 0,03	0,59 ± 0,08
CDVA	before rotací	0,90 ± 0,10	0,92 ± 0,05	0,89 ± 0,08
UDVA	6M after rotaci	1,00	1,00	1,00
Refraction	before rotací	0,38–1,63	0,25–1,25	0,50–2,00
	6M after rotaci	0,25–0,63	0,25–0,50	0,25–0,75
Rotation of IOL	deviation from axis	10,80 ± 2,41	8,20 ± 1,78	13,40 ± 3,04

regard to quality of close-up, middle distance and distance vision. Another important indicator was the expected degree of tolerance of photic phenomena. We did not indicate patients with unrealistic expectations for implantation of a T-MIOL. The value of corneal astigmatism was also naturally taken into account. According to the literature, correction of corneal astigmatism against the rule using a toric multifocal intraocular lens is suitable for defects of > Dcyl. According to the rule, correction of astigmatism is recommended at values of > 1 Dcyl (12, 13).

Correct calculation of the lens is of fundamental importance for the correction of corneal astigmatism with the help of a T-MIOL. We demonstrated this fact also in our study. As a result, before surgery examinations should be conducted in order to obtain the most precise possible values of keratometry and determination of the axis of astigmatism. No less important is correct interpretation of the measured values. We consider the performance of corneal topography to be essential in order to exclude the possibility of corneal pathology (e.g. irregular astigmatism and fruste form of keratoconus). It is suitable to use topographic systems on the basis of a Placido disc or Scheimpflug imaging, which furthermore offers the possibility of obtaining information also about the posterior surface of the cornea (22). It is necessary to keep in mind the fact that keratometries obtained from various instruments may differ in the axis of the cylinder by five degrees or more. Determining the “correct axis” of the cylinder may sometimes be difficult for this reason (4). On the basis of our experiences, it pays to devote maximum attention to the preoperative examination, and in the case of any ambiguities not to hesitate to repeat the examination. Upon planning the procedure it is of fundamental importance to perform calculation of the T-MIOL with determination of the spherical equivalent and value of the cylinder of the T-MIOL and determination of the axis of positioning and orientation of the lens. In this procedure it is necessary to avoid mistakes which could lead to the generation of a residual refractive error. This is frequently the cause of postoperative patient dissatisfaction. A residual refractive error is poorly tolerated above all in patients with astigmatism against the rule. However, patients who hitherto did not wear cylindrical correction and in whom preoperative corneal astigmatism is compensated by contact lenses may also be dissatisfied. Therefore, with regard to patient satisfaction, full correction of astigmatism appears to be of fundamental importance. Upon calculation it is also necessary to avoid producing an undesirable reversal of the axis of astigmatism. This situation may occur upon excessive correction of corneal astigmatism.

A fundamental prerequisite for the successful implantation of a T-MIOL is an uncomplicated course of surgery. The individual steps of the operation should be performed in such a manner as to ensure that the risk of rotation and decentration of the T-MIOL is reduced to a minimum. Optimally performed capsulorhexis is well centred and covers the edge of the optic part of the IOL along the entire perimeter. After implantation the lens is rotated in such a manner that the axis of the cylindrical component of the T-MIOL corresponds with the designated steep corneal meridian. After implantation the axis of the toric lens must be in accordance with the target corneal meridian. Complete removal of the OVD from the capsular sac is recommended in order to reduce the risk of undesirable rotation of the lens, behind the optical part of the lens. This manoeuvre prevents undesirable rotation of the intraocular lens on the cushion of the OVD in the first hours after surgery (7).

With the exception of minor modification in connection with the determination and marking of the axis on the eye and positioning of the implant in this axis, during the procedure with implantation of a T-MIOL the surgeon need not alter the surgical technique. Modification of the technique resides in preoperative marking of the referential points on the patient's eye, marking the axis of orientation of the lens and placing the implant in the required axis. With reference to cyclotorsion, it is necessary to devote maximum attention to the determination and marking of the axis. Cyclotorsion is most often around 3°, though a case of cyclotorsion to an extent of 17.5° has been described (2). For this reason it is recommended to indicate the axis in which the T-MIOL is to be oriented in the eye with the patient in sitting position (i.e. vertical position). Good results of postoperative refraction following the implantation of toric intraocular lenses depends on a precise comparison of the axis of the IOL with the steep corneal meridian.

One of the complications following implantation of a T-MIOL is undesirable rotation of the lens and its misalignment from the axis of astigmatism, with a resulting negative influence on the quality of vision. Misalignment of the T-MIOL can take place both due to its imprecise positioning during the operation and as a consequence of undesirable rotation of the lens in the postoperative period (6, 8). Rotation of the lens by 1° outside the axis means a reduction of the cylindrical value by approximately 3.3%. It is demonstrated that rotation of a toric IOL above 10° results in reducing correction by 1/3 and upon rotation by 30° the corrective effect of the IOL is entirely negated (14). Misalignment of > 30 degrees can lead to reversal of the axis without reduction of astigmatic correction (14, 12, 21). In our cohort the mean deviation from the planned axis of astigmatism was 10.8 degrees. Group B demonstrated a more pronounced deviation from the planned axis of the toric intraocular lens (13.4 degrees) after implantation of the toric multifocal intraocular lens AT LISA toric in comparison with group A (8.2 degrees) following the implantation of the toric multifocal intraocular lens AcrySof IQ ReSTOR Toric SN-D1Tx. We attribute this fact primarily to the differences in the total length of the lens, design of the haptics and the material from which the lens is produced. The correlation between the diameter of the IOL and the design of the T-MIOL on one hand and the size of the lens sac on the other is also not negligible. The intraocular lens AT LISA toric 909M has a total length of 11.0 mm in comparison with 13.0 mm in the case of the lens AcrySof IQ ReSTOR Toric. In our opinion, the better rotational stability of the lens AcrySof IQ ReSTOR Toric is thanks to the “open-loop” haptics and also the adhesiveness of the acrysof material with regard to the lens capsule. An evaluation of the rotational stability of individual toric implants should be an integral component of postoperative patient monitoring.

Both simple examination on a slit lamp furnished with a scale and sophisticated systems using digital retroillumination images obtained at the end of the operation and at a time interval after the procedure, with their mutual comparison using special software, can be used for monitoring rotational stability (19). Advances in the technology of guiding systems and intraoperational measurements performed during lens surgery enables us to plan the procedure more precisely, and facilitates more comfortable and precise performance of the operation, as well as better results. A number of computer controlled systems have appeared on the market recently, providing complete preoperative and postoperative assessment (e.g. VERIONTM Image Guided System, Alcon Laboratories Inc., Fort Worth, TX, CALLISTO eye® (Carl Zeiss Meditec AG). With the help of such systems we can measure the biometric parameters of the eye (keratometry, position and diameter of limbus, diameter and position of pupil, reflexive position of cornea), which helps us with the planning of the surgical data (e.g. localisation of corneal incision, positioning of limbal relaxation incisions upon correction of astigmatism) projected directly in the operating field.

It is necessary to be aware that reduced quality of vision may be caused not only by rotation of the T-MIOL, but also by its decentration. Decentration of an IOL mostly occurs as a consequence of asymmetrical fibrotisation of the edge of capsulorhexis and upon instability of the haptic part of the lens. The “stableforce” construction of the haptics in acrysof lenses creates constant compression, by which the lens also attains a consistent axial position (5).

In the case of deviation of the IOL from the required axis it is appropriate to perform surgical repositioning of the lens, residing in its rotation to the planned axis. Repositioning of the lens should be performed as soon as possible, at a time when the capsular sac can be easily opened and there are no present signs of fibrosis of the capsule. The optimum time for repositioning is within 10 days of implantation (4). Late surgical repositioning of toric intraocular lenses may lead to rotational instability as a consequence of fibrotisation of the lens capsule (encapsulation) and a higher risk of the occurrence of disinsertion of the zonular apparatus with subsequent instability of the T-MIOL in the eye.

In our cohort we performed a check on the position of the markers of the toric intraocular lens and evaluated them in mydriasis on a slit lamp, one week and six months after implantation. The rotational stability of AcrySof IQ ReSTOR Toric SND1Tx was up to 5° in 43 eyes. In 5 eyes with undesirable rotation of the IOL by 5-10° we performed surgical rotation. We did not record rotation of the lens greater than 10° in the group of eyes with the IOL AcrySof IQ ReSTOR Toric in any case. The rotational stability of AT LISA toric 909M lenses was up to 5° in 15 eyes, and in five eyes there was undesirable rotation between 10° and 17°. An improvement of quality of vision was achieved in all patients after surgical rotation of the IOL. The rotational stability of the T-MIOL was less than 5 degrees in all surgically rotated lenses in both groups 6 months after surgical rotation.

One of the most frequent causes of reduced quality of vision and subjective patient dissatisfaction with implantation of a T-MIOL is residual refractive error. Even despite advances in cataract surgery, results may sometimes be unsatisfactory as a consequence of residual refractive error. The causes of its incidence are various. It may concern imprecision of the biometric analysis (15, 16, 18), inappropriate selection of the strength of the intraocular lenses, limitation of the calculation of formulae or positioning errors of the T-MIOL (3). In our experience, residual refraction of +0.50 D – 0.75 Dcyl is usually still well tolerated by the patient. In the case of disruptive deviations from the emmetropic plan it is appropriate to consider supplementing laser corneal refractive surgery. We did not need to use laser correction of residual refractive error in any of the patients in our cohort for this reason.

We target postoperative refraction at emmetropia. However, even despite emmetropisation, visual acuity may not reach values of 1.0 in the first days after implantation. However, thanks to neuroadaptation, distance vision gradually improves. It is demonstrated that residual refractive error leads to a prolonging of the process of neuroadaptation to a multifocal image (17). For ideal postoperative adaptation of cortical functions (training of binocular functions, co-ordination of movements, search of distance, focusing of IOL etc.), bilateral implantation of a T-MIOL is recommended (5). Our experience also supports this recommendation.

Quality of vision and subjective patient satisfaction with a T-MIOL may be further reduced as a consequence of the incidence of pseudophakic dysphotopsia. This disruptive photic effect on the patient can be divided into positive (glare, halo) and negative (dark curved shadow in the temporal part of the visual field). Pseudophykic dysphotopsia is most probably caused by a fracture of the beams on the sharp posterior edge of the optic part of the IOL, or by rays fracturing on the surface of an IOL made of material with a high refractive index and insufficiently convex anterior surface (9). In the case of MIOLs this phenomenon is also attributed to the diffraction part of the optics (11). Disruptive photic phenomena are generally of a transitional character and thanks to the neuroadaptation process disappear within the range of a number of weeks to months. In our cohort the disruptive photic phenomena in the majority of patients were in connection with undesirable rotation of the T-MIOL. After rotation of the lens, subjectively disruptively perceived photic phenomena subsided. However, in a number of cases they may lead even to explantation of the IOL. In our cohort we did not record intolerance of photic phenomena leading to explantation of a T-MIOL in any case (20). After implantation of a T-MIOL, the neuroadaptation process takes an average of 4-6 months. In addition to training of adaptation to a multifocal image, coherence of the visual pathway also shares in neuroadaptation. The authors Kimiya Shimizu et al. conducted a neurophysiological study in which they performed replacement of a multifocal IOL with a monofocal lens in the dominant eye. The P-VECP amplitude increased, peak latency improved and the patient's symptoms subsided (17).

In our cohort all patients were capable of performing regular daily functions without dependence on glasses correction. Only two patients stated a more comfortable feeling with glasses correction when performing close-up work for a longer

duration. Absolute satisfaction with the resulting quality of vision six months after surgery was stated by more than 85% of patients, with 15% of patients rather satisfied. No patients were rather dissatisfied or dissatisfied. The high level of satisfaction with the resulting vision and very good tolerance of photic phenomena in the patients in our cohort is indisputably linked to the relatively strict indication criteria and careful selection of candidates for implantation of a T-MIOL. Upon an analysis of the causes of patient dissatisfaction, it is necessary to keep in mind that quality of vision may be reduced in the postoperative period e.g. as a consequence of opacification of the posterior capsule, a disorder of the surface of the eye (dry eye syndrome) or a pathology of the central landscape.

CONCLUSION

In patients with a cataract, implantation of a toric multifocal intraocular lens is a safe and effective solution both with regard to correction of corneal astigmatism and with regard to preserving multifocality of vision. An indisputable advantage of implantation of a T-MIOL is the fact that it simultaneously resolves both the spherical and astigmatic defect in a single procedure, and additionally provides patients with quality vision at all distances without dependence on glasses correction. Patient satisfaction with vision after implantation of a T-MIOL is high, even if this may not always be evaluated as such by the patient immediately after surgery. Within the framework of the neuroadaptation process, quality of vision progressively improves, and at a time interval of a number of weeks to months after surgery reaches its optimum level. Quality of vision in the postoperative period may be be reduced for a number of other reasons. This primarily concerns rotation of the lens and its misalignment from the axis of astigmatism, as well as residual refractive error and the incidence of disruptive photic phenomena.

On a general level, incidence of causes leading to surgical repositioning of a toric MIOL can be reduced above all by exact biometry with correct calculation of the toric intraocular lens and precise determination of the axis of astigmatism, as well as an uncomplicated course of the operation, with placement of the T-MIOL in the axis of astigmatism and thorough removal of the OVD from the retrolental area. Upon undesirable rotation of the T-MIOL it is appropriate to proceed to a timely surgical solution consisting in surgical repositioning of the lens and its surgical rotation to the axis of the steepest meridian. This manoeuvre leads to an adjustment of visual quality and an increase in patient satisfaction with the result of the operation, without dependence on glasses correction.

The resulting effect of the operation depends not only on the precision of the preoperative examinations and quality of performance of the surgical procedure and resolution of any applicable complications, but also on careful selection of candidates for implantation of a toric multifocal lens.

LITERATURE

1. **Baráková D., Hycl J., Továrek L.:** Současné trendy v chirurgickém řešení astigmatismu u pacientů s kataraktou. NEUMM 3/2008, New EU Magazine of Medicine, Medical Press s.r.o., Praha (www.neumm.cz).
2. **Ciccio A.E., Durrie D.S., Stahl J.E. et al.:** Ocular cyclotorsion during customized laser ablation. J Refract Surg, 2005; 21: S772–4.
3. **Erickson P.:** Effects of intraocular lens position errors on postoperative refractive error. J Cataract Refract Surg. 1990; 16: 305–311. 10.1016/S0886-3350(13)80699-2.
4. **Findl O.:** Toric Intraocular lenses. Current Medical Literature, 2012, Ročník 22, číslo 1, p. 1.
5. **Hayashi K., Masamuto M., Takimoto M.:** Comparision of visual and refractive outcomes after bilateral implantation of toric intraocular lens with or without a multifocal component. J Cataract Refract Surg, 2015; 41: 73–83.
6. **Holland E., Lane S., Horn J.D. et al.:** The AcrySof toric intraocular lens in subjects with cataracts and corneal astigmatism: a randomized, subject-masked, parallel-group, 1-year study. Ophthalmology 2010; 117: 2104–11.
7. **Horn J.D.:** Status of toric intraocular lenses. Curr Opin Ophthalmol, 2007; 18: 58–61.
8. **Jin H., Limberger I.J., Ehmer A. et al.:** Impact of axis misalignment of toric intraocular lenses on refractive outcomes after cataract surgery. J Cataract Refract Surg, 2010; 36: 2061–72.
9. **Kuchynka P. a kol.:** Oční lékařství, Grada Publishing, a.s. 2007, s. 812.
10. **Maedel S., Hirnschall N., Chen Y.A., Findl O.:** Rotational performance and corneal astigmatism correction during cataract surgery: Aspheric toric intraocular lens versus aspheric nontoric intraocular lens with opposite clear corneal incision. J Cataract Refract Surg, 2014; 40: 1355–1362.
11. **Mamalis N., Brubaker J., Davis D., Espandar L., Werner L.:** Complications of foldable intraocular lenses requiring explantation or secondary intervention - 2007 survey update. J Cataract Refract Surg, 2008; 34: 1584–91.
12. **Mašek P., Pašta J.:** 60 let nitrooční čočky. Edice oftalmologie. Nucleus- HK, 2010. s. 86–90.
13. **Mendicute J., Irigoyen C., Aramberri J., Ondarra A., Montés-Micó R.:** Foldable toric intraocular lens for astigmatism correction in cataract patients J Cataract Refract Surg, 2008; 34: 4,601–607.
14. **Novis C.:** Astigmatism and toric intraocular lenses. Curr Opin Ophthalmol 2000; 11: 47–50.
15. **Pierro L., Modorati G., Brancato R.:** Clinical variability in keratometry, ultrasound biometry measurements, and emmetropic intraocular lens power calculation. J Cataract Refract Surg, 1991; 17: 91–94.
16. **Raman S., Redmond R.:** Reasons for secondary surgical intervention after phacoemulsification with posterior chamber lens implantation. J Cataract Refract Surg, 2003; 29: 513–517.
17. **Shimizu K., Ito M.:** Dissatisfaction after bilateral multifocal intraocular lens implantation: an electrophysiology study. J Refract Surg, 2011; 27,4: 309–312.
18. **Snead M.P., Rubinstein M.P., Lea S.H., Haworth S.M.:** Calculated versus A-scan result for axial length using different types of ultrasound probe tip. Eye 1990; 4: 718–722.
19. **Teichman J.C., Baig K., Ahmed I.I.K.:** Simple technique to measure toric in-

traocular lens alignment and stability using a smartphone. J Cataract Refract Surg, 2014; 40: 1949–1952.
20. **Veselá M., Baráková D., Lenčová A.:** Analýza příčin explantace nitroočních čoček. Čes a Slov Oftal, 69,2013,No 4, s.170–173.
21. **Vlková E., Došková H., Vícha I.:** Initial experience with toric intraocular lenses. Čes a Slov Oftal, 2001May; 57(3): 161–4.
22. **Zhang L., Ellen M., Mai H., Yu F., Hamilton R.:** Effect of posterior corneal astgmatism on refractive outcomes after toric intraocular lens implantation. J Cataract Refract Surg, 2015; 41: 84-89.