

Evaluation of a novel eye-tracking navigation system in the alignment of toric IOLs in cataract surgery: a randomised control trial

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measure the Optical Density Ratio of the Corimap oximeter in both upright and supine position. For comparison, the ODR was also measured with an Oxymap T1 oximeter.

Methods: For this study, healthy volunteers (age 18–35) were recruited at the Leiden University Medical Center. The exclusion criteria were any ocular opacity, a medical history with ocular disease or systemic disease, which could affect ocular oxygen levels. After signing the informed consent and ophthalmological examination, one eye was randomly selected. After mydriasis, retina images were acquired with both Corimap Camera and Oxymap T1. The Oxymap T1 is a fundus camera based oximeter and the newly developed mobile Corimap camera is a handheld oximeter. Both dual wavelength oximeters acquire images in 570 nm and 600 nm. For the Corimap camera, images were captured in sitting and supine position. Images were processed by Oxymap Analyzer software for the calculation of Optical Density Ratio (ODR). The ODR has an approximately linear inverse relationship to oxygen saturation. A paired *t*-test was used for statistically analysis.

Results: In this study, healthy subjects ($n = 11$, 55% female, mean age 25 ± 1.9) were included for the measurement of ODR of the arterioles and venules. For the Corimap camera, the ODR of arterioles was upright 0.217 ± 0.044 and supine 0.244 ± 0.107 and for the venules was upright 0.533 ± 0.100 and 0.486 ± 0.130 supine. As for the Oxymap T1 the ODR was 0.204 ± 0.033 arterioles and 0.499 ± 0.064 or the venules. A paired *t*-test showed in all cases a statistical significant difference in the ODR of arterioles and venules ($p < 0.005$). The ODR values of the Corimap camera did not differ statically in sitting or supine position ($p > 0.05$). The ODR measurements between the Corimap oximeter and the Oxymap T1 oximeter were not statically different ($p > 0.05$).

Conclusion: With the introduction of this novel mobile and handheld oximeter, retinal oximetry will be applicable in a broader variety of diseases and patient populations. The Corimap can be used for measuring ODR and retinal vessel oxygenation in both sitting and supine patient position.

Type VII collagen in the accommodation system: expression in the ciliary body, zonules and lens capsule

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Introduction: Type VII collagen was recently discovered at the vitreoretinal interface. An interesting find, since this anchoring protein was thought to exist primarily in skin, where it fastens the epidermis to the dermis as a biological Velcro. In skin, it is particularly present in mechanical strained areas (e.g. palm of hand). The type VII collagen expression at the vitreoretinal interface was considered 'low', but so is the amount of local mechanical strain. In the accommodation system, however, considerable mechanical forces are being generated and transferred in order to gain refraction power. The accommodation system tissues are to endure such mechanical strain throughout our lives. The type VII collagen anchoring protein might therefore be expressed more pronouncedly in accommodating system tissues, as to support tissue integrity. We evaluated type VII collagen expression at the human accommodating system by immuno(histo)chemical analyses.

Materials and Methods: Nineteen human donor eyes (mean age 65 years) without known ophthalmic disorders were processed within 48 hr post mortem. Eyes were embedded in paraffin or Technovit resin, sectioned and immunostained using polyclonal and monoclonal antibodies against type VII collagen. Analysis was done by light- and transmission electron microscopy. Ciliary body, zonule and lens capsule homogenates were immunoblotted.

Results: Type VII collagen was demonstrated in most tissues of the accommodating system. Light microscopic overviews showed both pigmented and unpigmented ciliary epithelia to express type VII collagen profoundly at their basement membranes, primarily at the

bases of the ciliary processes and near blood vessels. The ciliary stroma immunostained poorly, the ciliary muscle moderately. The zonules immunostained strongest of all. Detailed analysis by immunoelectron microscopy showed inner limiting membrane labeling of membrane-incorporated structures. These structures were highly reminiscent of zonules, since both shared similarity in density and labeling intensity. The lens capsule also contained structures of zonular-like density and labeling intensity, but these structures were demarcated more clearly. No clear anchoring fibrils could be visualized in any of the tissues. The lens fibers and lens epithelia did not show any labeling, as did the negative controls. Immunoblot analysis confirmed type VII collagen existence in the various labeled substructures.

Conclusion: Type VII collagen is widely expressed in the accommodation system, particularly at basement membranes of strained tissues, and zonules. Type VII collagen is associated with zonule-like structures that were visualized in inner limiting membrane and lens capsule. The classical functional unit of type VII collagen, the Velcro-like anchoring fibrils, could not be visualized at the labeled areas. This could suggest an alternate anchoring mode of type VII collagen to skin in ocular tissues.

A new design of the capsular tension ring – further development: the closed ring

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Purpose: A disadvantage of a closed capsular tension ring is that a rigid (PMMA) closed ring would require a bigger incision, however a soft (silicone) closed ring might not provide sufficient support to the weakened zonulae. By using a super-elastic material we have been able to make a closed tension ring that provides more resistance to compression than the standard PMMA ring while allowing insertion through a 1.8 mm incision. The purpose of this study is to demonstrate the performance of the newly developed closed capsular tension ring.

Methods: Compression forces were evaluated as well as susceptibility to damage during manipulation. Insertion techniques were tested and stress on the zonulae was recorded and evaluated.

Results: The closed capsular tension ring has shown to provide a more homogeneous 360 degree resistance to compression compared to the open ended CTR. The use of a super-elastic material allows the CTR to be inserted through a very small incision without weakening it. The video analysis shows a reduced stress on the zonulae during insertion.

Conclusions: The closed capsular tension ring provides a better resistance to compression than regular open ended CTRs and reduces torsional tension during insertion. By using a super-elastic material it is possible to insert a closed ring through a very small incision.

Evaluation of a novel eye-tracking navigation system in the alignment of toric IOLs in cataract surgery: a randomised control trial

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Purpose: To evaluate the accuracy in toric IOL alignment using the VERION Image Guided System versus conventional, manual ink-marking procedure.

Setting: Single-centre randomised control trial performed in the University Eye Clinic Maastricht, the Netherlands.

Method: A total of thirty-six eyes (24 patients) with regular corneal astigmatism of at least 1.25 dioptres, who required cataract surgery and toric IOL implantation (Acrysof SN6AT3-T9), were randomly assigned to either the VERION-group or the manual marking-group. A first generation toric calculator was used for toric IOL calculations. The primary outcome was to evaluate the alignment of the toric IOL, by

using pre- and postoperative images immediately after surgery. Secondary outcomes were to compare postoperative residual astigmatism, uncorrected and best-corrected distance visual acuity (UDVA and BDVA), and complication profile. Vector analyses by Alpins was performed to determine astigmatism treatment.

Results: Preoperative mean corneal astigmatism was comparable between both groups (-2.35 ± 0.89 D vs. -2.42 ± 0.95 D, $p > 0.05$). Mean toric IOL misalignment immediately postoperatively was significantly less in the VERION-group ($1.3 \pm 1.6^\circ$ vs. $2.8 \pm 1.8^\circ$, $p = .02$). Three months postoperatively, misalignment, measured with slit lamp photography, was significantly less as well in the VERION-group ($1.7 \pm 1.5^\circ$ vs. $3.1 \pm 2.1^\circ$, $p < .05$). The mean subjective cylinder was -0.36 ± 0.32 D and -0.47 ± 0.28 D for the VERION- and manual-group ($p > 0.05$), respectively. All eyes achieved a refractive cylinder of 1.0 D or less. A refractive cylinder of 0.5D and 0.25D was achieved in 81% and 50% in the VERION-group compared to 71% and 33% in the manual-group. Postoperatively, UDVA and BDVA were 0.03 ± 0.10 logMAR and -0.05 ± 0.08 logMAR in the VERION-group versus 0.04 ± 0.09 logMAR and -0.04 ± 0.07 logMAR in the manual-group (both $p > 0.05$). Vector analyses showed a general overcorrection in the VERION-group with a correction index of 1.20.

Conclusion: Both digital and manual markings methods show high accuracy in aligning toric IOLs intraoperatively. Although this study did not show significant advantages in terms of UDVA and residual refractive astigmatism when using a digital marking system, IOL misalignment was significantly less after a digital as compared to a manual marking procedure. We believe the current difference might be more clinically relevant in a patient population with higher levels of pre-existing corneal astigmatism. Furthermore, the higher amount of overcorrection in the VERION-group, most likely induced by first generation toric calculators that neglect posterior astigmatism, might have masked the beneficial effect of a more accurate alignment procedure when using digital marking technology.

Intraoperative aberrometry versus standard preoperative biometry in non-toric and toric IOL calculations

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Purpose: To compare postoperative spherical equivalent predictions by intraoperative aberrometry (ORA, Alcon) and optical biometry (IOLMaster, Zeiss) for the non-toric IOL implantations and ORA compared to a toric calculator (Barrett) in toric IOL implantations.

Methods: A total of forty-one and 21 eyes were included in respectively the non-toric IOL group and toric IOL group. Patients in the non-toric IOL group underwent cataract surgery followed by implantation of either a monofocal IOL (SN60WF) or a multifocal IOL (SN6AD1). In the toric IOL group, patients underwent cataract extraction followed by the implantation of a toric IOL (SN6AT3-9). Optical biometry was used to calculate IOL powers in the non-toric IOL group, whereas a second generation toric calculator (Barrett Calculator, <http://www.ascrs.org/barrett-toric-calculator>) was used to determine the toric IOL power. Intraoperative aberrometry was used to perform an aphakic measurement in all eyes. Spherical equivalents (SE) of the both the preoperative calculations and ORA measurements were compared to postoperative achieved SE. The primary effectiveness outcome was the proportion of eyes within 0.25 D, 0.50 D, and 1.00 D SE between predicted and achieved SE (prediction error).

Results: In the non-toric IOL group, mean postoperative achieved SE was -0.39 ± 0.79 D, compared to -0.41 ± 0.65 D and -0.42 ± 0.61 D predicted by respectively the IOLMaster and ORA. The prediction error was ≤ 0.25 D, ≤ 0.50 D, and ≤ 1.00 D in respectively 52%, 81%, and 94% of cases performing IOL calculation with the IOLMaster compared to 65%, 90%, and 100% when performed using the ORA (all $p > 0.05$). The mean prediction error was 0.41 D and 0.29 D when using respectively the IOLMaster or the ORA ($p > 0.05$).

In the toric IOL group, mean postoperative achieved SE was -0.02 ± 0.57 D, compared to -0.22 ± 0.61 D and -0.09 ± 0.41 D predicted by respectively the Barrett Calculator and ORA. The prediction error was ≤ 0.25 D, ≤ 0.50 D, and ≤ 1.00 D in respectively 39%, 71%, and 94% of cases performing IOL calculation with the Barrett Calculator compared to 50%, 78%, and 100% when performed using the ORA (all $p > 0.05$). The mean prediction error was 0.48 D and 0.31 D when using respectively the Barrett Calculator or the ORA ($p > 0.05$).

Conclusion: In this study we analysed the predictions in postoperative outcomes calculated by the IOLMaster for non-toric IOL implants and Barrett Calculator for toric IOL implants, compared to the predictions determined by the ORA using aphakic measurements. The mean predictions error was low for all three calculations. No significant differences were seen either comparing the percentages achieving a specific residual SE or in mean prediction error. However, the prediction error was slightly lower in the ORA group in both the non-toric and toric IOL group. Furthermore, a higher percentage of predictions performed by the ORA were ≤ 0.25 D and ≤ 0.50 D as compared to both the IOLMaster and Barrett Calculator predictions.

Straylight from glistenings in IOLs: an in vitro study

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Purpose: Glistenings are small fluid-filled vacuoles in intraocular lenses (IOLs) and induce scattering of light. In this study, we assessed light scattering from IOLs with laboratory-induced glistenings and created a model for predicting the effect of glistenings on straylight.

Methods: Glistenings were induced in 7 AcrySof IOLs (Alcon Inc.) using an accelerated aging method. The glistenings were analyzed under a microscope. Light scattering from the studied lenses was assessed using a commercial straylight meter (C-Quant) adapted for in vitro evaluation of IOLs at a scatter angle of 2.5° and 7°. A model was proposed relating the amount of straylight to the total number and surface portion (SP, the total number \times area) of glistenings.

Results: The median size of induced glistenings in the IOLs was 5.4 ± 2.7 μ m (range, 4.6 to 12.5 μ m). The number of glistenings ranged from 114 to 12 386 per mm², covering the IOL (i.e., SP) from 1.4% to 26.9%. At the 2.5° scatter angle, the range in straylight parameter was 1.49 to 72.49 deg²/sr; at 7° it was 1.72 to 72.87 deg²/sr. Straylight was proportionally related to the total number of glistenings (i.e., $0.0046 \times$ total number; $R^2 = 0.96$) and to the SP (i.e., $217 \times$ SP; $R^2 = 0.97$).

Conclusion: We found a proportional relation between the total amount of glistenings in IOLs and their functional effect on straylight. The SP of glistenings showed a similar relationship with straylight. The proposed model proved effective in predicting straylight from glistenings. A large number of glistenings is needed to cause straylight elevation that is clinically relevant to the patient.

YAG capsulotomy rates in an angulated sharp edged hydrophilic multifocal IOL

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Purpose: To report the cumulative incidence of Nd-YAG capsulotomy rates in a multifocal hydrophilic IOL.

Methods: Prospective case cohort. In 324 eyes implanted between 2011 and 2015 the incidence of Nd-YAG laser capsulotomy was analyzed.