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Artificial lens replacement in own experiences. What determines the success of this procedure?

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Abstract

The article describes the author's experiences related to the replacement of an artificial lens with a different model. Reasons for the procedure are described and attention is paid to the stages of lens removal that may affect the final result of the procedure. Lens replacement procedures were performed by one surgeon in the period from one month to over 6 years from the initial implantation procedure. Calcification, glistening and subsequent opacification of the artificial lens are among the main reasons for removing an artificial lens after several years. Removal of the lens in a short time, up to 15 months, resulted from the desire to see without glasses to far and near distances, the presence of a residual defect, and the quality of vision unacceptable to the patient related to the implantation of a premium class lens. The presence of secondary cataract greatly facilitates the lens replacement process.

Keywords: Lens replacement; Calcification; Glistening; Cataract surgery; Lens opacification; Eye trauma

1. Introduction

Cataract removal is the most frequently performed surgical procedure in ophthalmology [1]. A dozen or so years ago it was the only reason for removing the lens. Currently, removal of a clear lens in the process of correcting the existing eye defect not acceptable for the patient has become the second most frequent surgical procedure [2].

Over the last few decades, lens surgery has undergone many changes and modifications aimed at obtaining and maintaining a good quality vision for many years. The technique as well as the material and construction of the artificial lens implanted into the eye after removal of the patient's own lens, have changed. Going back to the beginnings of cataract surgery, the mere removal of opaque lens was sufficiently successful allowing the patient to return to the "world of the seeing", despite the presence of a large eye defect of hyperopia associated with the emergence of postoperative aphakia. With time, after intraocular lenses appeared, the postoperative defect acceptance limit has continued to decrease.

Nowadays, diagnosing a postoperative eye defect of 1-2 diopters is unacceptable, at least in the case of commercial procedures. The presence of a postoperative defect may result from many factors, ranging from the error in calculating the power of an artificial lens, through the occurrence of a surgical complication and ending with the implantation of a premium class lens, which is simply not accepted by the patient due to the conditions of the eye structure [3].

The presence of an unwanted postoperative eye defect, especially in patients who have decided to have the lens removed as a form of correction of the existing eye defect is unacceptable to both the patient and a self-respecting ophthalmological surgeon. This condition requires a repair-correction procedure.

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In recent years, a “flood” of premium class lenses and their increasing use have been observed. In order to obtain the best vision quality after their use, one should carefully become familiar with the structure of the lens intended for implantation, the structure of the optical system of the eye and the patient’s expectations in order to “pair” all these elements together into a favorable whole.

Is the use of the lens with EDOF technology in a patient with a small pupil with a diameter of 3 mm, additionally in the dominant eye, a good option for eye correction? It is not. Is it possible to calculate the correct power of an intraocular lens for an eye “filled” with silicone oil, forgetting that the refraction in the eye will change when it is removed? The above reasons are just examples of consequences that may lead to the need to replace an intraocular artificial lens with a different model.

Objective

Retrospective analysis of results obtained in the process of replacing an intraocular artificial lens with another model. The procedures were performed by one surgeon between 2015 and 2020, in a private medical center - Silesian Eye Treatment Centre in Żory (Poland).

2. Material and methods

The lens replacement procedure was performed in 34 patients (41 eyes), including 7 bilaterally. In 3 patients, the artificial lens was replaced twice with another model due to the patients’ dissatisfaction caused by the appearance of a residual eye defect or unacceptable quality of vision. Mainly hydrophilic lenses were replaced, which is important in terms of their lower adhesion to the lens capsule.

In 7 eyes, the removed artificial lens was made of a hydrophilic material. The mean age of the patients was 62 years, ranging from 21 to 81. The shortest time after which the artificial lens was replaced was about 3 weeks. In such a short time, the lens was replaced in three patients. In one case, the multifocal lens was replaced with a monofocal model due to the patient’s dissatisfaction with the quality of postoperative vision. In another patient, who underwent refractive lens replacement surgery (RLR) due to the presence of hyperopia (+6.0Dsph), the surgeon decided to replace the premium class lens with a model from another proven company due to the appearance of a residual eye defect at the level of +2.0Dsph. The last and the youngest patient suffered blunt eye trauma with subsequent traumatic cataract and damage to the iris sphincter. A calculating error caused the appearance of a defect of -3,0Dsph, which in the case of implantation of a multifocal lens required its replacement.

The replacement of intraocular lenses after a very long period of time, on average after 5 years, was performed for 3 reasons. The main reason involves progressive calcification of the artificial lens. Another one is a significant visual impairment due to glistening. The third one is the replacement of a monofocal lens with a trifocal model, performed in a 28-year-old man. Although the reason for this patient’s consultation was the deterioration of visual acuity caused by the appearance of posterior capsular opacification (PCO), due to his young age and the possibility of safe lens replacement, the patient was offered the option of simultaneous replacement of the lens model and removal of capsular opacification. Below is the link to the video presenting this surgery:
https://www.youtube.com/watch?v=OWznWiXn_uo&t=1s

The reasons for the lens replacement procedure were divided into 4 groups.

- Group 1. Calcification and glistening, 10 people (12 eyes),
- Group 2. Replacing a monofocal lens with a premium class lens, 10 people (12 eyes)

The main reason was the desire to get rid of correction of visual acuity to near distances, and in some patients also to far distances, due to inadequate calculation of the power of the lens intended for implantation, mainly in the case of combined procedures, cataract removal with posterior vitrectomy.

- Group 3. Replacing a premium class lens with a monofocal lens, 10 people (12 eyes).

The main reason was the desire to improve the quality of vision.

- Group 4. Other reasons, including inadequate postoperative correction, visual impairment caused by macular abnormalities, which occur after posterior vitrectomy, 4 people (5 eyes).

All the above reasons, number of patients, methods of lens implantation are included in Table 1.

Table 1 Reasons of surgery, number of patients, methods of lens implantation

The reason for replacing the artificial lens with a different model	Number of eyes / patients	Lens implantation: IC- into capsular bag OC - on the anterior capsule F - intrascleral fixation
Lens calcification, replacing the bifocal lens with the same, bifocal model	10/8	IC 5 OC 4 F 1
Glistening, replacing the lens with another monofocal model	2/2	F
Monofocal to multifocal lens - desire to see to near distances without additional correction, no other reasons	8/6	IC
Monofocal to bifocal lens, after posterior vitrectomy, desire to obtain vision to near distances without correction	2/2	IC
Calculating error. After posterior vitrectomy. Anisometropia. Replacing the lens twice. 1. Monofocal to trifocal toric lens. 2. Replacement with a bifocal toric lens	1/1	IC
Calculating error. Premium class lens for a different, premium class model, eye after blunt trauma	1/1	IC
Multifocal to monofocal lens - unacceptable quality of vision	6/5	IC
Multifocal lens with a monofocal model. Dysfunction of the macula after posterior vitrectomy procedure (retinal detachment, macular hole).	4/4	IC
Error in calculation of the lens power. Condition after vitrectomy. Anisometropia. Monofocal lens with another monofocal model with a different power.	2/1	IC
Replacement of a rigid artificial lens with a model to intrascleral fixation, combined with iris plastic surgery. Poor quality of vision. Lens tilting	2/2	F
Replacing of subluxated, artificial lens with a different model for intrascleral fixation	3/2	F

Qualification criteria for lens replacement.

Apart from the fundamental reasons mentioned above, the qualifying examination included a few stable elements. Most of them are used in the routine qualification for cataract removal or refractive lens replacement (RLS).

One of the most important is the assessment of the condition of the lens capsule for the presence of secondary cataract, lens subluxation and the presence of posterior Yag capsulotomy.

The presence of secondary cataract and the absence of posterior Yag-capsulotomy is a very favorable and, at the same time, the most important prognostic factor for artificial lens removal and re-implantation of a lens into the capsule, even many years after the initial surgery.

Another important factor is the examination to assess the number of endothelial cells and the corneal pachymetry. A low number of endothelial cells increases the risk of permanent postoperative corneal edema [4].

2.1. Other stable qualification steps include:

- Physical examination of the anterior and posterior segment of the eye, after pupil dilation.
- Assessment of pupil function and the condition of the iris stroma.
- Examination of non-corrected and best-corrected visual acuity to far and near distances.
- Examination of intraocular pressure.

2.2. Additional examinations performed before the replacement of a monofocal lens with a premium model included:

- Aberrometry of the optical system using Itrace.
- Topographic assessment of the cornea in case of qualification for implantation of a toric lens.
- Evaluation of the macula in OCT.
- Visual field examination in eyes that underwent posterior vitrectomy or patients who reported visual field defects.

2.3. Stages of the procedure:

- Topical anesthesia and pharmacological pupil dilatation.
- Two side entrances allowing for the introduction of additional anesthetic and then tools, such as a spatula and a hook inside the eye.
- Introduction of viscoelastic into the anterior chamber.
- Attempt to separate the lens capsule from the artificial lens. In the case of one-piece bifocal, lenses from Oculentis, it is better to start the separation process in the lower quadrants. The impossibility to separate the lens from the capsule resulted in the removal of the entire lens-capsule complex.
- After separating the anterior capsule from the lens, introduction of viscoelastic under the optics and around the haptics. Administration of viscoelastic should cause progressive separation of the capsule from the individual lens elements.
- If there is visible aperture after posterior Yag capsulotomy, do not introduce too much viscoelastic under the optics because of the high risk of unwanted enlargement of the aperture.
- “Activation” of the haptics of the lens gently pulling towards the optics of the lens and sideways.
- In the case of a tri-pieces lens, the impossibility to separate the haptics from the capsule without damaging it or completely tearing it resulted in cutting the haptics off from the optics and leaving them in the eye.
- Removal of the artificial lens from the capsule into the anterior chamber of the eye.
- Cutting the optics into two parts and then removing them from the eye through a 2.4-3mm incision. In the case of hard non-foldable lenses, consider making a scleral incision of a specific length.
- In the case of secondary cataract - removal of cells from the surface of the capsule using a bimanual technique, irrigation-aspiration. (https://www.youtube.com/watch?v=OWznWiXn_uo)
- Anterior vitrectomy in the eyes with an aperture after posterior Yag-capsulotomy and after removal of the lens-capsule complex. In most cases, posterior Yag capsulotomy is accompanied by the fragmentation of the capsule surrounding the vitreous from the front, with its subsequent flow towards the anterior chamber of the eye.
- Filling the anterior chamber with viscoelastic or introducing a maintainer to obtain the correct eyeball tension.
- Introduction of the lens inside the capsule or on its anterior surface through the main incision previously made.
- In the absence of a support in the form of a lens capsule, introduction of a lens intended for transscleral fixation. In this case, the Carlevale lens by Soleko is preferred.
- Corneal wound hydration.

3. Results

3.1. Anatomical state

The replacement of the “unwanted” intraocular lens with a different model was performed in all patients. Implantation into the bag succeeded in 29 eyes, which constitutes over 70% of all procedures. In 4 eyes (9.7%) the lens was placed on the capsule. Anterior vitrectomy was performed in 8 eyes (19.5%), mainly with an aperture in the posterior capsule after Yag-capsulotomy and after removal of the lens-capsule complex. Replacing lenses, which were initially implanted a few or several months earlier, was not problematic for the surgeon.

In 7 patients (8 eyes = 19.5%) intrascleral fixation was performed using the Carlevale model by Soleko, the lens of choice, due to its stable fixation in the eye [4]. The reasons for this procedure include the impossibility to remove the

lens without disturbing the surrounding capsule (3 eyes) and artificial lens subluxation due to a broken fixing suture. The hydrophobic lens was removed together with the capsule in two patients who experienced a significant deterioration of vision due to glistening.

Calcification of lenses with subsequent deterioration of vision constitutes the main reason for their replacement. The pathology involved bifocal lenses by Oculentis, with the exception of one case of a monofocal lens by a different company. Taking into account the slowly progressing opacification process, the replacement procedure was performed within 5-6 years from the initial lens implantation.

Below are the links to two videos which present removal of calcified lenses from both eyes.

https://www.youtube.com/watch?v=OWznWiXn_uo&t=1s and

<https://www.youtube.com/watch?v=eo2QWykM42U>

As it happens in the learning curve process, the first lens was removed along with the capsule, so the intrascleral fixation procedure was performed with the use of a 4-haptic bifocal lens, model LU 814 MF30 by the same company. In each of the eyes with diagnosed calcification, subsequent implantation of a bifocal lens was performed, trying to maintain vision to far and near distances without the need for additional correction. The same lens, model - LU 814 MF30 was also used in the eyes with the posterior capsulotomy aperture. One patient (1 eye) had successful capsular lens implantation performed despite the presence of a posterior capsulotomy aperture. However, this type of procedure is quite risky. In the last case, after removing the calcified, opaque lens, an attempt to introduce it into the capsule despite the presence of a small aperture after posterior laser capsulotomy ended in posterior vitrectomy due to the artificial lens implant subluxation into the vitreous chamber. Consequently, the third lens, the LU814 MF30 model, was placed on the front capsule.

In the presence of preserved undamaged posterior capsule, its continuity was not broken during the lens replacement process.

The shape and size of the capsule has changed over time. This process is also influenced by the appearance of posterior capsular opacification-secondary cataract (PCO). Overall, in most eyes in which no PCO was diagnosed, the shape of the capsule mirrored the shape of the lens. In these cases, in order not to damage the lens capsule, consider introducing the same lens model or a model with a similar structure. This mainly affects eyes in which an artificial lens was implanted many years ago.

As mentioned before, the presence of PCO is a beneficial factor that facilitates the removal of the artificial lens. Secondary cataract occurs mainly in the eyes with hydrophilic lenses implanted. The appearance of the capsular epithelial cells, causing lens opacification, prevents the formation of a permanent connection between the capsule and the artificial lens. Other reasons for the appearance of secondary cataract include implantation of the optics outside the lens capsule or their poor adhesion to the capsule due to large capsulorhexis. In the latter cases, the type of material the lens is made of does not affect the strength of adhesion and thus for the appearance of PCO [5].

3.2. Complications

There were no cases of eye inflammation requiring non-standard postoperative treatment. The time of the procedure was extended compared to a routine removal of the patient's lens, at least in the case of the first procedures.

3.3. Intraoperative complications.

The artificial lens most often adheres strongly to the capsule in its peripheral, lower part with the haptics due to the formation of membranes strongly connecting the capsule and the lens. During their removal and when pulling the lens, in 3 (7.3%) cases the lens zonules were partially torn. In order to keep the correct shape, a capsular tension ring was inserted into the capsule.

Posterior vitrectomy was performed in one patient (1 eye - 2.43%), who experienced artificial lens subluxation when the artificial lens was being introduced into the bag, despite an irregular aperture after the posterior Yag-capsulotomy.

3.4. Postoperative complications

It is mainly temporary edema of the cornea. This condition, which lasted up to several days, was observed in 20 eyes, which constitutes 48.7% of all procedures. Chronic edema developed in 3 eyes (7.31%), of which in one eye (2.43%), from which the lens was removed due to a significant degree of opacification (glistening), edema did not resolve. The eye required a corneal transplantation. In this case, the number of endothelial cells was not calculated preoperatively, while their number tested in the other eye was less than 700/mm² (corneal degeneration).

Transient hemorrhage into the anterior and vitreous chambers was observed in 8 eyes (19.5%) in which transscleral fixation was performed. Another complication was a transient increase in intraocular pressure, observed in 14 patients (14 eyes - 34%). All complications related to the procedure are listed in Table 2.

Table 2 Complications related to lens replacement.

Complication	Number of eyes	% share of complications
Transscleral fixation	8	19.5
Anterior vitrectomy	8	19.5
Transient corneal edema	20	48.7
Transient increase of intraocular pressure	14	34
Transient intraocular hemorrhage	8	19.5
Chronic corneal edema	3	7.31
Capsular ring implantation	3	7.31
Replacing the artificial lens twice	2	4.87
Corneal transplantation	1	2.43
Posterior vitrectomy	1	2.43

3.5. Visual acuity

Its postoperative values were assessed in the period from 2 to 6 months. The best values for visual acuity were taken into account. The assessment of visual acuity and quality of vision was performed after the division of patients into individual groups.

- Group 1: Lens calcification and glistening.

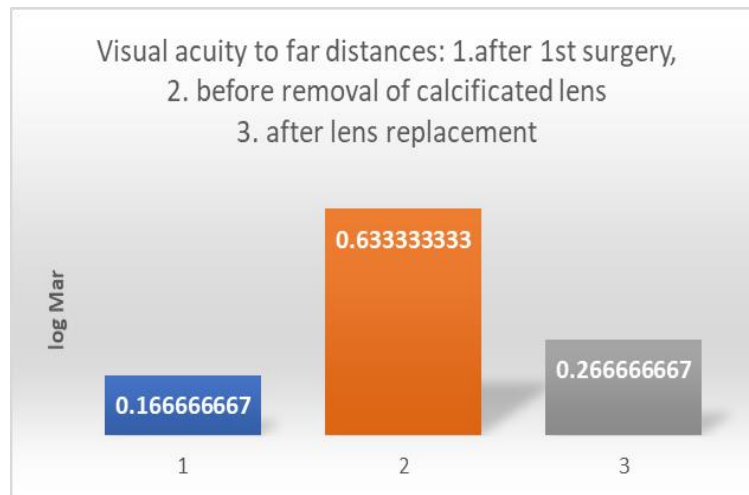
In this group, a comparative analysis of the best values of visual acuity to far distances, without correction, obtained 6 months after the initial procedure, before the opaque lens removal and 2 months after the artificial lens replacement procedure, was performed.

The obtained average values are presented in the form of Graph 1.

Visual acuity to far distances after lens replacement improved significantly, although its values were inferior to the best values obtained after the initial surgery. Lower values of visual acuity were obtained in patients whose lens required intrascleral fixation.

In a 58-year-old woman glistening occurred in the eye with recurrent uveitis. Lens replacement (intrascleral fixation) improved visual acuity to far distances from 1.0 to 0.5 logMar.

In the above group values of visual acuity to near distances were comparable.

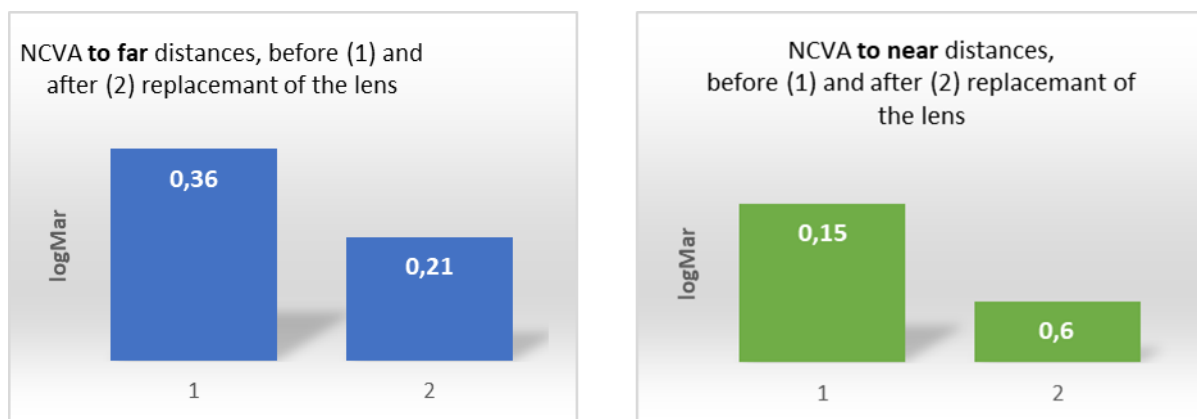


Graph 1 Values of visual acuity to far distances gained in three situations: after patient’s lens removal, before removal of calcificated lens and, after lens replacement.

- Group 2

In this group, the monofocal lens was replaced with the LS-313 MF 15 or 30 model by Oculentis, most often. In this way, most patients got rid of their glasses worn to improve vision to near distances or intermediate distances. Using the same model of the lens in another 3 people (3 eyes), the preoperative defect of vision to far distances and astigmatism were additionally corrected. Astigmatism in two patients (3 eyes) was corrected using the limbal relaxing incision (LRI) method. One of the patients underwent lens replacement twice - from a monofocal to trifocal toric AT LISA lens, and then to a bifocal toric lens by Oculentis, model LS MF30T, due to insufficient visual acuity to near distances. Before the procedure of removing the lens and reattaching a detached retina in the eye, the patient was diagnosed with high myopia and corneal astigmatism.

An average non-corrected visual acuity (NCVA), distance and near, are presented in the form of Graphs No. 2a, b



Graph 2a NCVA to far distances and, 2b. NCVA to near distances before and after lens replacement.

Visual acuity to far and near distances improved, which does not mean that the patients got rid of their glasses completely. The need to wear glasses resulted from several factors, including the state of vision of the other eye and eye domination.

- Group 3

In this group, mostly the unacceptable quality of vision, mainly to far distances and under scotopic conditions, was the factor that led to lens replacement. In 6 people (6 eyes), the lens was replaced with a monofocal lens, and in another 3 (4 eyes) the bifocal lens with an addition to near distances of +3.0 Dsph was replaced with a model with the addition to near distances of + 1.5Dsph.

Loss of vision to near distances without correction is the main “negative” value of this procedure, but a significant improvement in the quality of vision was achieved. Blurred vision to far distances, halo, and glare symptoms, especially visible under scotopic conditions, almost completely disappeared.

- Group 4

It is mainly the replacement of the subluxated and tilt artificial lenses using the intrascleral fixation technique with Carlevale lenses by Soleko. In two cases (after trauma), the procedure combined with iris plastic surgery was performed. In another case, the incorrect power of the artificial lens and post-injury iris sphincter lesion resulted in the need to replace it with a different model combined with iris plastic surgery, which was performed twice to reduce the pupil size. This procedure was described in a separate article [6]. Transscleral fixation using sutures, according to the author’s experiences, with time may result in a suture breaking and the subsequent subluxation, so another safer procedure is recommended. Each “entry” into the eye leads to a progressive loss of endothelial cells with all its consequences. Visual acuity to far distances improved from a mean value of 1.0 to 0.6 (logMar).

4. Discussion

There are not many papers published in recent years dealing with replacement of an artificial lens with another model [6]-[7]. As the results of this study show, replacement of an artificial lens, despite a relatively high percentage of transient complications, is a safe and effective procedure, so it is worth introducing it. Safety of this type of procedure was also demonstrated by Goemaere et al. in their latest study, published in December 2020, describing 15 years of their own experiments during which the procedure was performed in 492 eyes [8].

As in any newly introduced procedure or surgical technique, at the beginning of the so-called learning curve, there are temporary complications which, with time, after knowing them better, can be alleviated or even completely avoided. When analyzing individual groups of patients undergoing the procedure, several thoughts have come to the fore.

As for replacement of a lens due to its calcification, if it results from the lens production process, then as customers we have no influence on the condition of the lens we have purchased, but, protecting ourselves or the patient, we can apply for compensation for the patient.

However, we can avoid most of the reasons why the lenses in the described group of patients were removed and replaced with a different model.

The most important factor is the correct qualification and thus the choice of the lens for implantation.

Patients who have had a premium class lens removed and replaced with a simpler or different model are most often those in whom stringent qualifying criteria were not applied, such as measurement of aberrometry of the optical system, including the kappa angle (asymmetric, bifocal lenses ie. Mplus by Oculentis) and the alpha angle, which in practice is not, but should be, the qualification standard in centers that perform such procedures. One example of replacing a bifocal lens due to poor night vision is the case of a 45-year-old professional driver. The patient, wanting to get rid of glasses worn to improve vision to far and near distances (defect before the procedure: to far distances + 2.0 Dsph), was classified (both eyes) for the implantation of a bifocal lens with the addition to near distances of + 3.0Dsph (Mplus by Oculentis). Postoperative visual acuity (VA) was excellent. In the dominant eye VA to far distances reached -0.2, in the non-dominant eye it reached -0.1 (logMar). Reading was also fluent, reaching D-0.5 (Snellen) in both eyes, examined separately. But in a dim or scotopic light he started to complain about glare. One year after the first surgery the lens in the dominant eye was replaced with a similar model, but with the addition to intermediate distances of +1.5Dsph. Most of adverse vision effects have disappeared.

Another reason for the replacement is the introduction of a premium class lens, model that has not yet been sufficiently tested under test conditions. There are more and more products with a complex structure on the market, the number of implantations of which in the world amounts to only a few dozen. In the available publications on such products, the emphasis is mainly placed on demonstrating the beneficial aspects of their use. As a result, we, as customers, get to know the less often described negative aspects of such lenses, becoming a test group. Knowing the structure of the lens that we want to use helps to adjust it to the structure and expectations of the patient.

Another problem is the calculation of the correct power of the intraocular lens in patients who underwent posterior vitrectomy requiring silicone oil endotamponade. If we need to remove the patient’s lens intraoperatively, it is better to

calculate its power before the procedure, assuming that the condition of the retina allows for it. Another option is to leave the eye aphakic, and then calculate its power, and implant it after removing the silicone oil. The last version, least recommended, especially when we want to introduce a premium class lens into the eye, is to calculate its power taking into account the fact that silicone oil causes refractive error.

Replacing a monofocal lens with a premium class lens can also be avoided if the patient is sufficiently informed about all options for aphakia correction, including the use of not only monofocal lenses. In this case, however, a lot depends on the doctor, his/her knowledge, and skills. A patient who comes to a center where the only product recommended and used is a monofocal lens, learns about other forms of aphakia correction when he/she comes to a center that in everyday practice also uses premium lenses.

5. Conclusion

Replacing an artificial intraocular lens with a different model is a procedure worth recommending due to its high efficiency and low risk of permanent complications. The condition is to follow the appropriate qualification standards before the procedure. The procedure gives good postoperative results even when we have to remove an implant that has been present in the eye for over 5-6 years. The ease of replacement of the lens increases in the presence of secondary cataract, which reduces the adhesion strength of the artificial lens to the capsule. The absence of an aperture in the posterior capsule resulting from Yag-capsulotomy greatly increases the chances of introducing another lens into the capsule. The short time (up to several months) from the moment of initial lens implantation is a favorable factor in the process of lens removal and replacement. The lower the adhesion strength of the lens to the capsule, the greater the chance of its problem-free removal. Proper preoperative qualification based on sufficient medical knowledge, good knowledge of the structure and operation of the artificial lens that we offer to the patient, and learning about the patient's expectations allows us, in most cases, to avoid the type of procedure that will always be associated with a certain degree of risk of intraoperative and postoperative complications.

Compliance with ethical standards

Statement of informed consent

An Informed consent was obtained from all individual participants included in the study.

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