

# Assessment of Postoperative Anterior-Posterior Shift of AcrySof SP Lens in Time and its Impact on Resulting Refraction

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## SUMMARY

**Purpose:** The present study assesses the anterior-posterior shift of the AcrySof SP intraocular lens in the eye between the third and fifteenth month after surgery.

**Methods:** The observed set contained a total of 241 eyes operated for cataract at Beskydské oční centrum (Beskydy Eye Centre; BOC), Frýdek-Místek hospital from 7 February 2007 to 7 April 2010. All surgeries were performed through microcoaxial phacoemulsification and a 2,2 mm incision, with intraocular lens (IOL) AcrySof type SP implanted. For each eye, we examined BCVA, as well as anterior chamber depth by optical biometry (IOL-Master, Carl Zeiss GmbH, Jena), 3 and 15 months after the surgery. Average depths were calculated and compared; and their variations converted from mm to diopters. Based on the BCVA results, we were able to determine optimum dioptric power of the IOL, which should have been implanted in the eye to ensure postoperative emmetropia. Averages of all values were calculated and results thereof compared.

**Results:** We noted a slight average deepening of the anterior chamber depth (0,03 mm) causing a hypermetropic shift of 0,05 D, insignificant in terms of refraction. Though comparison of average optimum IOL values calculated based on examinations carried out 3 and 15 months after surgery, we ascertained an actual zero difference between the two values.

**Conclusion:** Through our own calculations, we verified very good stability of the implanted hydrophobic acrylic SP AcrySof lenses in our set, with zero haptic angulation. There is de facto no anterior-posterior shift of the IOL between 3 and 15 months after surgery, and therefore no change in refraction noticeable by the patient.

**Key words:** anterior-posterior shift, anterior chamber depth, optimum value of intraocular lens dioptric power, intraocular lens stability

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## INTRODUCTION

In order to be considered successful, contemporary modern cataract surgery must fulfil a range of attributes for the patient. At the workplace where the actual surgery is performed it is necessary to manage all the procedures logistically in such a manner as to ensure that the patient is satisfied with the entire process of preparation, the actual surgery and the postoperative condition.

Nevertheless, evidently the most important factor from the perspective of long-term patient satisfaction with the result of the surgery is indisputably the most precise possible determination of the dioptric power of the intraocular lens which is to be inserted into the eye, and which is to ensure the patient's sharp vision without the necessity of additional correction by means of eyeglasses to the distance designated by the patient according

to the type of intraocular lens (IOL). In recent years, pressure for the best possible refractive result has increased with the development of implantology of multifocal lenses and other types of lenses, which enable sharp vision without additional correction to distance, for reading and if possible also for middle distance (trifocal lenses, pseudoaccommodative lenses etc.).

For an assessment of the long-term stability of the postoperative refraction of the eye, it is therefore also very beneficial to know whether a shift of the IOL will occur in the eye after the surgery over time, and if this occurs, how this shift will influence the resulting vision, and whether it is appropriate to calculate with this influence upon determining the dioptric power of the implanted IOL.

At the Beskydy Eye Centre we have been implanting practically only AcrySof intraocular lenses in regular cataract surgery since 2004, and only the Single-piece type (SP) since 2006.

We began implantation of AcrySof IOL in 1998, and as of the end of 2012 we had registered a total of over 16 thousand implantations of these lenses of various types. We have very good experience with the properties of these lenses, including their stability in the eye. As a result we wished to parametrically verify the stability of AcrySof SP IOL on our own population.

## MATERIAL AND METHODOLOGY

The population includes the total of 241 eyes, which were operated on for cataract at the Beskydy Eye Centre at the Frýdek-Místek hospital in the period from 7 February 2007 to 7 April 2010. The sample is composed of 112 right eyes and 129 left eyes. The average age of the patients in the population was 71 years; their age range on the day of operation was from 43 to 88 years.

The sample did not include eyes with findings of epiretinal membranes, with

cicatrical stage of ARMD, advanced maculopathy of various aetiology with apparent oedema, eyes following surgeries of the posterior segment or following refractive corneal procedures. All the surgeries were performed by the total of three ophthalmic microsurgeons in approximately equal proportions, using the same surgical procedure with the help of the same phacoemulsification instrument (Infinity System, Alcon Research Ltd., USA, 2007), by the method of microaxial phacoemulsification via an opening with a diameter of 2.2 mm located by no. 12 and implantation of a soft intraocular lens AcrySof SA60AT, AN60AT (natural – with yellow filter, see Fig. 2) or SN60WF (with aspheric adjustment), via an equally wide incision. For the proportion of implantations of individual types of IOL see Fig. 1.

AcrySof lenses are produced from patent-protected copolymer, which is a combination of two different hydrophobic acrylate polymers – 2-phenylethyl acrylate (PEA) and 2-phenylethyl methacrylate (PEMA). A lens produced from this copolymer has a very high refractive index (2, 7, 11), which enables the production of a very thin lens with excellent optical properties (7). Since its introduction into production, copolymer has demonstrated high biocompatibility and very good adhesive properties, which provide excellent adhesion of the lens to the internal surface of the posterior capsule. The haptics of a single-piece AcrySof SP lens have the patented configuration stableforce, which ensures compression-balanced force of the optical part of the lens onto the posterior capsule. On the basis of this configuration, the haptics also ensure stable placement of the lens in lens sacs of various sizes, perhaps

with only exception of extremely large myopic eyes (13, 14). Thanks to these biomechanical properties, long-term postoperative stability is seen in the eye for AcrySof lenses (6, 10, 14, 15). We excluded from the sample eyes with surgical complications which could have caused a non-standard position of the IOL in the lens sac upon its scarring, above all radial ruptures of the anterior capsule or implantation of a distance ring for a loose suspended apparatus of the lens. Eyes with complications which caused the necessity of implantation of an intraocular lens (IOL) outside of the sac were also excluded. Placement of an IOL in the sulcus would significantly influence the results of postoperative refraction of the eye, in conflict with the sense of the set targets of the study. As a result, all eyes in which a rupture of the posterior capsule occurred were excluded.

The patient was examined as an outpatient 3 months after the surgery using the same instruments in the same eye clinic of our centre according to the procedure set in advance for the operated eye. With regard to the aim of the study, emphasis was placed on a precise examination of BCVA, and the depth of the anterior chamber of the eye was measured with the help of an IOL-Master (manufacturer Carl Zeiss GmbH, Jena). In the case of patients who underwent an examination 3 months after the surgery and attended an additional examination 1 year later (15 months after the surgery) on the basis of our request, we performed another examination by an analogous method.

We carried out an analysis of the data of the studied population and a statistical and graphic assessment thereof with the help of the program Microsoft Excel® 2003.

In the study we used two different methods, namely:

**a) Comparison of average values of depth of anterior chamber from examinations 3 months and 15 months after the surgery**

In each eye in the sample we measured the depth of the anterior chamber (ACD) with an IOL-Master at examinations 3 months and 15 months after the surgery. We calculated the average of the depths, compared the averages, converted them from mm to dioptres according to the coefficient stated in the literature: 0.1 mm ACD = 0.19 D (5) and recorded the results in the table.

**b) Comparison of optimal values of dioptric power of IOL from examinations 3 months and 15 months after operation**

In each eye we examined BCVA 3 months and 15 months after the operation, we converted the necessary additional correction in spherical dioptres to additional correction for the implanted intraocular lens according to the quotient 1.0 D in glasses = 1.23 D in IOL. We obtained this quotient from software of a US biometer, which enables determination of the dioptric power of an IOL according to the required postoperative refraction. We then added the dioptric value of this additional correction to the actual value of the dioptric power of the implanted IOL.

Thus obtained resulting value in dioptres can be considered to be the optimal value of dioptric power of IOL which was to be implanted into the lens sac in order to ensure postoperative. We did not deal with astigmatism of the cornea because we started out from the assumption that a surgical incision with a width of 2.2 mm is astigmatically mute.



Fig. 1 Proportion of implantations of individual types of IOL

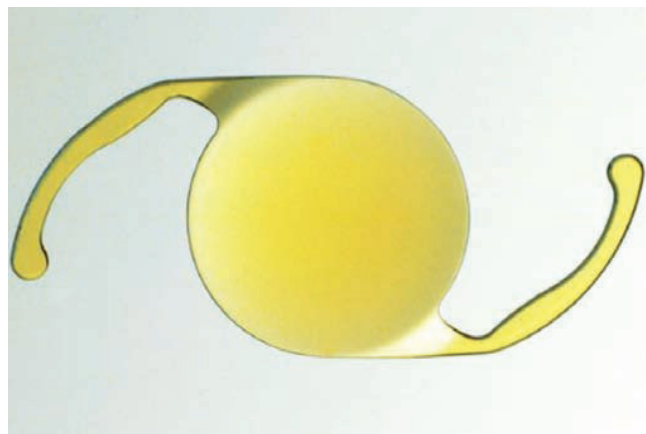


Fig. 2 IOL AcrySof SN60AT

From all the values we calculated the average, and mutually compared the resulting averages.

## RESULTS

### a) Comparison of average values of depth of anterior chamber from examinations 3 months and 15 months after surgery

The results (see Table 1) record absolutely minimum changes of the depth of the anterior chamber in the eye in the period between the 3rd and the 15th month after the surgery. The conversion of the depth of the anterior chamber to dioptres and the calculated differences show that with the exception of the subsample of extremely long eyes (26 mm and more), no pronounced changes to the values of subjective refraction which the patient was able to register took place (3). In the case of extremely long eyes we record a myopic shift in the average of around -0.80 D, though from the perspective of an objective assessment of this result the sample is too small.

### b) Comparison of the optimum values of dioptric power of IOL from examinations 3 months and 15 months after surgery

The results (see Table 2) converted into the optimal dioptric power of IOL monitor the anterior-posterior shift of

the lens in the eye by another method. As can be seen, the difference in the average optimised values of IOL is -0.01 D, which is an absolutely negligible value from the perspective of possible subjective registration of change of vision on the part of the patient (3). In fact, in the case of normal lengths of the eye (22.0-24.49 mm) in our population, the resulting difference was 0.00 D, so here we do not record any change of refraction whatsoever within the observed time frame. In the case of very long eyes the resulting difference was -0.21 D, and in very short eyes -0.18 D. These subsamples, however, include a very small number of eyes, which considerably relativises the calculated result.

## DISCUSSION

The majority of authors record a shift in various types of intraocular lenses in the period of 1 to 2 months after surgery in a forward direction, although by the maximum of 0.1 to 0.15 mm (1, 4, 14, 15). A very small myopic shift therefore takes place, maximally up to -0.2 D (14). In our population also we detected the average difference between the dioptric power of the actually implanted IOL and the dioptric power of the optimise IOC, calculated from the result of BCVA 3 months after the operation, which was

at the level of -0.25 D. If we omit the very small interval of very long eyes, which evidently distorts this average result, the residual average myopic deviation in our population is -0.15 D (see Table 2).

Because BCVA in our population was not examined until 3 months after surgery, it is not possible to distinguish well which part of this myopic deviation is at the expense of the postoperative shift of the IOL in the eye and which part of the deviation is caused by our method of selection of the dioptric power of the IOL. At the Beskydy Eye Centre (BOC) we are used to implanting an IOL rather in the direction towards preserving a very small residual postoperative myopia in the case of emmetropias and myopias.

In the further postoperative period there are factually either no further shifts of the IOL or only minute shifts, rather in a backwards direction towards the retina (9, 14). Almost zero change in the optimum values of the dioptric power of the IOL in the further postoperative period (Table 2) or the only minute hypermetropic shift of the IOL (Table 1), which we present in our results, essentially concurs with the data in the literature (3, 8, 9, 14).

From the results it ensues that AcrySof SP hydrophobic acrylate lenses have very good long-term stability from the perspective of the anterior-posterior

**Table 1** Average deviations of anterior chamber depth (ACD) according to length of eye 3 months and 15 months after surgery

Length of eye (AL) (IOL-Master)	Number of eyes	ACD 3 months after op.	ACD 15 months after op.	Difference of deviations	Conversion of mm to dioptres (D)
mm		mm	mm	mm	
26.0 and more	4	4.63	4.21	-0.42	-0.80
25.99 – 24.5	20	4.35	4.34	-0.01	-0.02
24.49 – 22.0	191	4.11	4.16	+0.05	+0.09
21.99 and less	26	3.95	3.97	+0.02	+0.03
<b>Overall</b>	<b>241</b>	<b>4.13</b>	<b>4.16</b>	<b>+0.03</b>	<b>+0.05</b>

**Table 2** Average resulting optimum value of dioptric power of IOL over time

Length of eye (AL) (IOL-Master)	Number of eyes	Average of impl. IOL	Average of optim. IOL after 3 months	Difference in averages of impl. IOL and optim. IOL after 3 months	Average optim. IOL after 15 months	Difference of averages of optim. IOL after 3 and 15 months
mm		D	D	D	D	D
25.99 – 22.00	217	21.62	21.47	-0.15	21.48	+0.01
26.00 and more	4	13.75	12.62	-1.13	12.41	-0.21
25.99 – 24.5	20	18.03	17.75	-0.28	17.79	+0.04
24.49 – 22.0	191	22.00	21.86	-0.14	21.86	0.00
21.99 and less	26	26.67	26.62	-0.05	26.44	-0.18
<b>Overall</b>	<b>241</b>	<b>22.03</b>	<b>21.78</b>	<b>-0.25</b>	<b>21.77</b>	<b>-0.01</b>

shift in the eye, ensuring a practically constant refraction of the eye (3, 8, 13, 15).

It is a question for discussion as to whether the optimum solution is to incorporate also the very small myopic shift which takes place within the period of a few weeks after surgery into the final calculation of the designation of the correct dioptric power of the IOL. A shift of up to -0.2 D is so small that in a summary of all the factors which may negatively influence the final calculation of the optical density of the IOL, it is

very difficult to work with this, partially due to the uncertainty of its factual level, and partially due to the limitation placed by the interval of production of the lenses, which is ordinarily 0.5 D.

## CONCLUSION

In our population we recorded very good stability of the AcrySof SP implanted hydrophobic acrylate lenses. In the period of 3 months to 15 months after surgery, no changes occur in the refraction of the eye which would re-

quire correction by eyeglasses. With regard to the data in the literature, which identify a very small myopic shift upon a high frequency of examinations in the early postoperative period (first 2 months) in the majority of eyes, it is evidently appropriate to consider this circumstance in the final preoperative calculation of the intraocular lens, especially in the fine nuances of decision making and assessment e.g. as to whether this concerns an eye originally with a myopic or hyperopic refraction.

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