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Intraocular lens decentration and posterior capsule opacification: Anatomo-pathologic findings after implantation of AMOSI40 IOLs

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PURPOSE. *To evaluate the incidence of intraocular lens (IOL) decentration and posterior capsule opacification (PCO) after implantation of a three-piece posterior chamber silicone IOL in a series of eyes examined postmortem.*
METHODS. *Twenty-three pseudophakic enucleated human cadaver eyes, implanted with AMO SI40NB IOLs after phacoemulsification, were analyzed. Eyes obtained postmortem were sectioned at the equatorial plane and the anterior segment photographed from a posterior view. Location of IOL optic and haptics, type of fixation, and centration of IOL was evaluated. PCO was graded and the presence of Nd:YAG laser posterior capsulotomy was noted.*
RESULTS. *Mean age at the time of surgery was 77.83 years, mean time since implantation was 18.26 months. In all the eyes examined, IOL haptics were positioned in the capsular bag. Mean decentration was 0.20±0.16 mm. No correlation was found between IOL decentration and time since implantation. The degree of peripheral PCO ranged from none (13.0%) to mild (39.1%) to moderate (26.1%) to severe (21.7%). The degree of central PCO ranged from none (52.2%) to mild (30.4%) to moderate (4.3%). Three patients (13.0%) underwent Nd:YAG laser posterior capsulotomy.*
CONCLUSIONS. *A very good centration can be obtained when silicone AMOSI40NB IOLs are correctly implanted with the haptics inside the capsular bag. About half of the implants showed no central PCO while Nd:YAG laser posterior capsulotomy rates documented a relatively low PCO 18 months after surgery. A careful in the bag haptics placement is needed in order to reduce the IOL decentration and to prevent central PCO. (Eur J Ophthalmol 2006; 16: 46-51)*

KEY WORDS. *Cataract, IOL, Posterior capsule opacification*

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INTRODUCTION

Modern cataract surgery techniques have led to the expectation of rapid visual and physical rehabilitation after surgery. The development of small incision phacoemulsification surgery and foldable posterior chamber intraocular lens (PC IOL) implantation has the advantage of inducing a minimal incision-induced corneal astigmatism (1-4).

With the introduction of continuous curvilinear capsulorhexis (CCC), in-the-bag haptic fixation has been reported to be one of the major factors in reducing the two most frequent long-term complications of extracapsular cataract extraction with PC-IOL implantation: IOL decentration (5-7) and posterior capsule opacification (PCO) (8-15).

Common causes of IOL decentration and dislocation have been reported to be asymmetric loop placement, loss of zonular support, and pupillary capture of the IOL optic.

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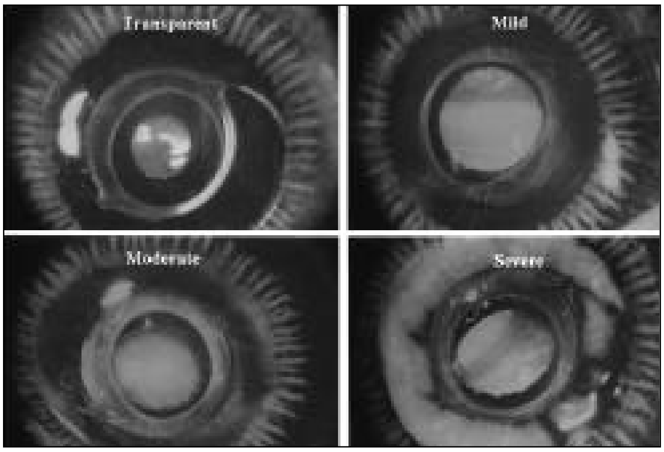

Fig. 1 - *Posterior capsule opacification grading. Posterior capsule opacification was graded in transparent posterior capsule (-), mild (+), moderate (++), and severe (+++) capsular opacification.*

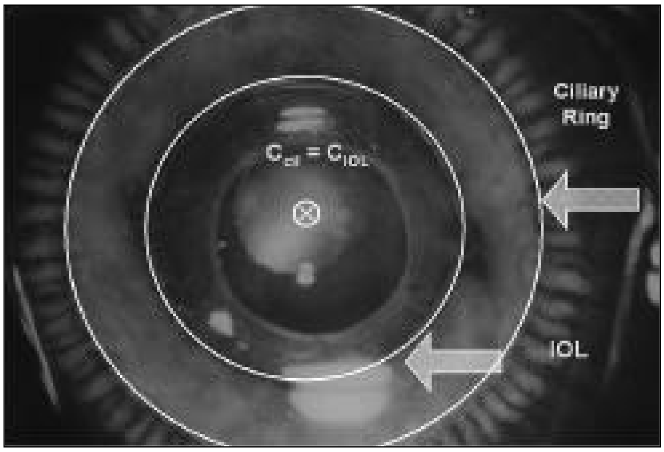

Fig. 2 - *Intraocular lens optic centration was measured using the center of the ciliary ring (C_{cil}) as reference. In the case reported, no decentration was evident (decentration = 0.00 mm).*

Since continuous curvilinear capsulorhexis has became the standard technique for anterior capsulotomy followed by in the capsular bag IOL placement, the incidence of these complications was greatly reduced (16, 17).

Secondary cataract formation has been reported to be a major complication after extracapsular cataract extraction, occurring in up to 50% of eyes, and its treatment with Nd:YAG capsulotomy is not without complications (12, 18, 19).

The importance of the IOL as a factor affecting the incidence of PCO is well recognized (20).

The role of IOL material has been postulated, and a biomaterial causing less stimulation for cellular proliferation in the lens capsular bag has been sought.

Acrylic lenses, in particular AcrySof IOLs, have been reported as having very low rates of PCO when compared with polymethylmethacrylate (PMMA) and silicone IOLs (21, 22).

This reduced incidence of PCO has been attributed to a bioactivity of IOL material and a consequent reduced epithelial cell growth on the posterior capsule (23).

Recent works suggested that lens implant design rather than lens material may be the more important factor in the prevention of PCO (24). Nishi et al have shown that lens epithelial cells (LECs) migration from the equator of the capsular bag can be inhibited by the IOL edges (25).

The following report is an evaluation of enucleated human cadaver eyes implanted with AMO SI40NB IOLs.

The aim of our study was to evaluate centration of the IOL implanted and PCO.

MATERIALS AND METHODS

A series of 23 pseudophakic enucleated human cadaver eyes was evaluated. The eyes examined were human autoptic material obtained after enucleation during autopsy. Pseudophakic globes previously implanted with AMO SI40NB IOLs (Allergan Medical Optics, Irvine, CA) after CCC and phacoemulsification were explanted and included in the study. AMO SI40NB IOL is a three-piece posterior chamber IOL, with an overall length of 13 mm, a 6-mm rounded-edge biconvex silicone optic, and PMMA haptics.

Each globe, fixated in 10% neutral buffered formalin, was sectioned at the equatorial plane. After bisection, the posterior segment was discarded and the anterior segment examined (26). Gross examination from behind allowed evaluation of morphology of the PC-IOL loop configuration, identification of location of IOL optic and haptics, and therefore type of fixation (i.e., bag-bag [B-B], bag-sulcus [B-S], and sulcus-sulcus [S-S]) and centration of the IOL.

The anterior segment was photographed from a posterior perspective, under an operating microscope. Posterior capsule opacification was evaluated as central (within the IOL optic) and peripheral (peripheral to the IOL optic) and then graded in clear posterior capsule (-), mild opacification (+), moderate (++), and severe (+++) opacification (Fig. 1). The presence of Nd:YAG laser posterior capsulotomy was noted and central posterior capsule opacification was graded as moderate for those cases.

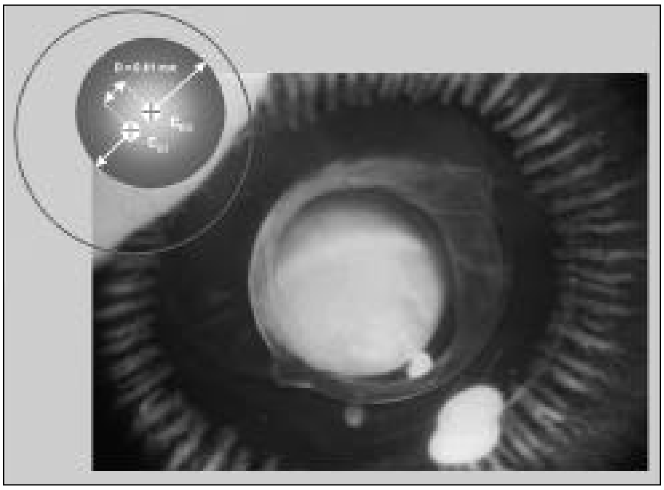

Fig. 3 - *Intraocular lens (IOL) optic decentration was measured, evaluating the distance between the center of the anterior segment (C_{cil}) (determined by the circumference of the ciliary body) and the center of the IOL optic (C_{IOL}). In the case reported, decentration (D) was 0.61 mm.*

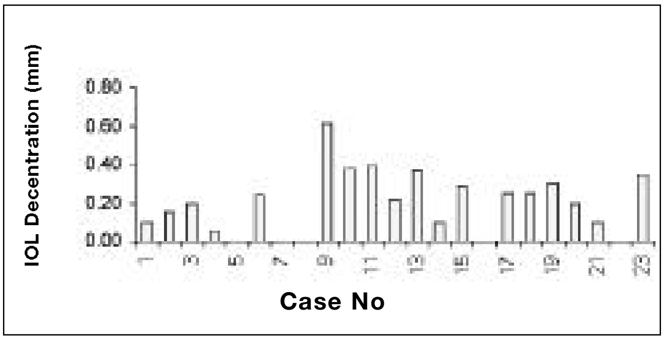

Fig. 4 - *Intraocular lens decentration.*

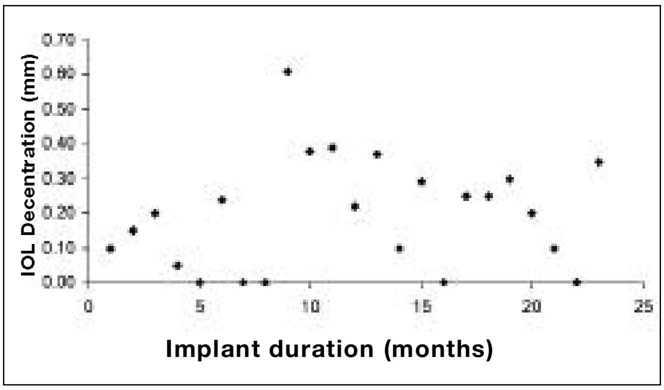

Fig. 5 - *Intraocular lens decentration and implant duration.*

Centration of IOL was evaluated and measured using the center of the ciliary ring (C_{cil}) as reference (8). In order to measure IOL optic decentration, slides of the anterior segment were projected.

The distance between the center of the ciliary ring (C_{cil}) (identified by the circumference of the ciliary body) and the center of the IOL optic (C_{IOL}) was measured (Figs. 2 and 3). This decentration value was converted to real millimeters of IOL decentration, knowing the IOL optic diameter (6.0 mm), by the following proportion:

projected decentration : projected optic diameter = X : real IOL diameter

IOL decentration values were then correlated to implant duration. The presence and grade of PCO was correlated to implant duration.

RESULTS

Twenty-three enucleated human cadaver eyes have been evaluated (Tab. I). Patients' age at time of surgery ranged from 69 to 88 years (mean 77.83 years) while mean implant duration was 18.26 months (range 6 to 39 months).

In all the eyes examined, IOLs were in the capsular bag fixated (B-B fixation).

Mean decentration was 0.20±0.16 mm, ranging from 0.00 to 0.61 (Fig. 4). In 22 eyes (95.6% of cases) decentration was within 0.4 mm and only in 1 eye (4.4% of cases) reached 0.61 mm (Fig. 3).

No correlation was found (t-test) between IOL decentration and duration of implantation (Fig. 5).

Peripheral and central PCO rates related to implant duration are summarized in Table II.

Peripheral PCO was absent in 13.0%, while it was mild in 39.1%, moderate in 26.1%, and severe in 21.7% of total cases. Central posterior capsule was transparent in 52.2% of total cases, while it was mild in 30.4% and moderate in 4.3% of cases.

Three patients (13.0%) had undergone Nd:YAG laser posterior capsulotomy.

Peripheral PCO was present in 66.7% of eyes in a mild grade, within 12 months after surgery, while it was moderate in 36.4% of cases after a period between 13 and 24 months and severe in 50% of eyes more than 24 months after surgery.

Central posterior capsule was clear in 83.3% of eyes within 12 months after surgery.

A moderate central PCO was present in 18.2% of eyes considering a duration of implantation between 13 and 24 months and in 33.3% of eyes more than 24 months after surgery.

TABLE I - DECENTRATION AND PERIPHERAL OR CENTRAL POSTERIOR CAPSULE OPACIFICATION (PCO)

Case	Age at surgery, yr	Implant duration, mo	Decentration, mm	Peripheral PCO score	Central PCO score	YAG
1	74	15	0.10	++	+	No
2	88	39	0.00	++	+	No
3	78	22	0.20	+++	++	Yes
4	79	16	0.05	+	-	No
5	79	27	0.00	+++	++	No
6	71	29	0.24	+++	-	No
7	73	20	0.15	++	++	Yes
8	83	6	0.00	+	+	No
9	84	6	0.61	-	-	No
10	83	21	0.38	++	-	No
11	77	12	0.39	-	-	No
12	73	17	0.22	+++	+	No
13	68	11	0.37	+	-	No
14	80	22	0.10	++	+	No
15	84	25	0.29	+	-	No
16	84	15	0.00	-	-	No
17	73	25	0.25	++	+	No
18	88	16	0.25	+	+	No
19	73	14	0.30	+	-	No
20	73	9	0.20	+	-	No
21	80	26	0.10	+++	++	Yes
22	69	6	0.00	+	-	No
23	76	21	0.35	+	-	No
Mean	*77.83*	*18.26*	*0.20*			
SD	*5.81*	*8.25*	*0.16*			

PCO was graded in clear posterior capsule (-) and mild (+), moderate (++), or severe (+++) opacification. The presence of YAG capsulotomy was noted

TABLE II - PERIPHERAL AND CENTRAL POSTERIOR CAPSULE OPACIFICATION (PCO) AND IMPLANT DURATION

	Peripheral PCO (eyes)			
Implant duration, mo	**-**	**+**	**++**	**+++**
0-12	2	4	0	0
13-24	1	4	4	2
>24	0	1	2	3
Eyes, total (%)	3 (13.0)	9 (39.1)	6 (26.1)	5 (21.7)
	Central PCO (eyes)			
	-	**+**	**++**	**+++**
0-12	5	1	0	0
13-24	5	4	2	0
>24	2	2	2	0
Eyes, total (%)	12 (52.2)	7 (30.4)	4 (17.3)	0 (0.0)

DISCUSSION

Posterior chamber IOLs have the advantage of being placed in the position of the original crystalline lens thus leading to a more physiologic situation. Posterior chamber IOLs require the presence of a posterior capsule and can be either placed in the sulcus or in the capsular bag. Capsular bag placement has been shown to be superior to sulcus placement in terms of centration and PCO (27, 28). IOL haptics, when inside the bag, offer a symmetric stability to the IOL optic, whereas when IOL haptics are placed asymmetrically in and outside the capsular bag or in the sulcus, a lack of stability is possible with a consequent IOL decentration.

The change in cataract surgery technique to smaller incisions required the use of folding IOLs. In 1995 the 3 mm incision technique has been reported to be used by 38% of surgeons with 14% using silicone and 9% using acrylic IOLs (29). PMMA remained the gold standard and was still the preferred material in 1995 (29). Silicone IOLs have been in use since the early 1980s with Food and Drug Administration (FDA) approval obtained in 1990 for a three-piece silicone lens.

Silicone lenses were reported to be the most popular folding IOLs (29), having the longest track record with millions of silicone lenses implanted worldwide and positive visual results (30).

In our study the incidence of decentration and PCO in eyes implanted with AMO SI 40 NB IOLs have been evaluated. Lens decentration and dislocation have been described as a much rarer complication with the in-the-bag positioning of the lens implant following CCC (27). In our study, in all the eyes examined the IOLs were in the bag fixated and showed a good centration, which is consistent with literature (31).

PCO remains the most frequent complication, despite improvement in surgical technique and also considering the effect of IOL design in reducing its incidence. With modern cataract surgery, a decrease in the incidence of PCO has been reported (18, 31) and confirmed by several clinical studies (21, 22, 32-34). As the expected rates of PCO are decreasing, subsequently the need of Nd:YAG laser capsulotomy will be reduced.

In the capsular bag haptic fixation has been reported as an important factor in reducing the incidence of PCO, as the IOL design can act as a barrier for the migration of lens epithelial cells from the equator to the center of the posterior capsule (28, 35). The barrier effect is maximal when the lens is fully inside the capsular bag, in direct contact with the posterior capsule, and is enhanced by the posterior angulation of the IOL haptics and the posterior convexity of the optic. The incidence of in-the-bag IOL fixation has grown over the years (31) and crucial has been the introduction in surgical practice of a CCC with a diameter slightly smaller than the IOL optic, which helps in keeping the IOL optic in the capsular bag (13).

From our data we can confirm that accurate IOL haptics fixation has to be considered as the most important factor in obtaining good centration. An optimal centration guarantees a maximal optical correction and visual rehabilitation. The in-the-bag fixation can on the other hand help to reduce PCO incidence, allowing achievement of the maximal effect from IOL design in preventing IOL migration.

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