INTRODUCTION

Continuous curvilinear capsulorhexis, phacoemulsification and in-the-bag placement of the intraocular lens represents the standard of care for cataract surgery. Capsulorhexis was a great hit in phacoemulsification, allowing a safe place for IOL implantation. However, the technique is not without complications, with capsular shrinkage and dislocation of the capsular bag-IOL complex being the most important ones in the short and long term respectively.¹

Late spontaneous in-the-bag dislocation of the intraocular lens (IOL) is a potential complication of cataract surgery in which an IOL that is adequately placed within the capsular bag -with or without capsular tension ring-, decenters many years after uneventful surgery.² The three aforementioned requirements –late, spontaneous and in-the-bag fixation of IOL- must be fulfilled to establish the diagnosis. Differently from in-the-bag dislocation, out of the bag dislocation typically occurs early after surgery and it is caused by rupture of the equatorial capsule or tearing of the posterior capsule.³ Also, cases of in the bag IOL dislocation which are the result of an external trauma, whether accidental or iatrogenic (history of vitrectomy or intraoperative zonular dialysis) should no be categorized as late and/or spontaneous. Some authors arbitrarily chose a cut-off of three months as the limit between early and late, regarding in-the-bag IOL dislocation,⁴,⁵ very different from the mean interval of typical cases of late in-the-bag dislocation which has been estimated in 7.5 years.²,³,⁶-¹¹ Early in-the-bag dislocation is more likely
the result of zonular damage during surgery. These different conditions differ from in-the-bag IOL dislocation in the interval between original surgery and dislocation, predisposing factors, and management.\textsuperscript{2,3} Reports in the literature are scarce and only a few of them include a relatively high number of patients.\textsuperscript{2-11} In addition, there is considerable confusion in current literature on this topic, usually dealing with all the above mentioned entities as a whole without providing separate data on some of the outcome measures.\textsuperscript{3,8,10}

The exact incidence of this complication is difficult to estimate given the long time frame for presentation and varies widely. Recently, Swedish population-based data estimate late in-the-bag chamber IOL dislocation requiring surgical intervention to have an annual incidence of 0.05\% in western Sweden –one third of cases were out of the bag\textsuperscript{10} and a 10-year cumulative incidence of 1\% in northern Sweden,\textsuperscript{4} while a similar approach in Minnesota yielded a 10-year cumulative risk of 0.1\% -including a 44\% of out of the bag cases, and extracapsular cataract extraction cases-.\textsuperscript{5} This 10-fold lower IOL dislocation estimate in southern Minnesota compared with Sweden at 10 years after surgery in part may be the result of a higher prevalence of pseudoexfoliation in the Swedish cohorts, the main risk factor for in-the-bag IOL dislocation.

Several authors found an increase over these years in the number of patients requiring surgery for late in-the-bag IOL dislocation at their centers, raising concerns of an epidemic of IOL dislocations.\textsuperscript{2,7-9} It is not clear whether this is because the pseudophakic community is growing and/or whether the type of cataract surgery technique also plays a role. However, the above mentioned population studies were unable to demonstrate significantly an increased rate of incidence.\textsuperscript{5,10} In fact, our own recent data show that the number of surgeries increased yearly from 2004 to 2007 but it has remained stable since 2007 to 2012 (Lorente R, unpublished data 2012). In any
case, although its actual incidence seems to be low, the potential burden to society of this condition could be considerable, because longer life spans and as the number of people undergoing cataract surgery increases. In our country, a recent study has identified IOL dislocation as the main cause of IOL explantation, accounting for 56% of cases, with 40% of them being in-the-bag subluxations.\textsuperscript{12}

The mechanisms that lead to IOL dislocation are two-fold: progressive zonular weakness and capsule contraction syndrome, with the exact contribution of each mechanism varying on a case-by-case basis.\textsuperscript{7} Zonular weakness with or without capsule shrinkage leads to an unbalance between centrifugal and centripetal forces over the capsular bag, resulting in dislocation. Entities that have been associated with progressive zonular dehiscence are pseudoexfoliation, by far the main risk factor, connective tissue disorders and high myopia.\textsuperscript{2,3,6-11} When it comes to the role of capsule contraction syndrome, we must bear in mind that late in-the-bag dislocation was virtually unreported before the popularization of capsulorhexis. The centripetal forces on the zonule caused by the fibrosis around an intact capsulorhexis are more pronounced than on the irregular edge of a can-opener capsulotomy and recent studies have found that dislocation occurs earlier in cases with capsular fimosis.\textsuperscript{11} Some degree of capsule contraction is common in most eyes, but profound capsule shrinkage has been described in pseudoexfoliation, diabetes mellitus, uveitis, pigmentary retinal degeneration and myotonic dystrophy.\textsuperscript{7}

The main risk factor identified consistently in all series is pseudoexfoliation (66.6% of cases),\textsuperscript{2,3,6-11} being the only factor which role has been confirmed on a case–control study.\textsuperscript{5} Additional case control studies should be desirable to assess and weight the importance of the other mentioned predisposing conditions. This information would be of outmost importance to identify patients at risk and to design preventive strategies.
Dislocation can be classified as follows\(^2\) (Table 1): Grade I, pseudophakodonesis (no visual symptoms); Grade II, bag held by only a few superior zonular fibers (zonules) and most of the inferior fibers. Dislocation of the capsular bag with the superior edge of the IOL above the visual axis. Slight decrease in visual acuity; Grade III, all superior zonules are broken and the capsular bag is suspended from some remaining inferior zonules (the superior edge of IOL remains below the visual axis, with a severe decrease in visual acuity); Grade IV, all zonules are broken and the IOL is dislocated into the vitreous cavity with a severe decrease in visual acuity.

Time between original surgery and dislocation is usually long (8.06 ± 3.3 years). And it is significantly shorter in cases in which a CTR is present within the capsular bag (4.9±1.9 years).\(^2,11\)

**MANAGEMENT**

Management of in-the-bag IOL dislocation requires special considerations. A variety of therapeutic options are available, including repositioning or replacement.\(^1-11\)

Observation is an alternative only in cases presenting pseudophakodonesis without inferior dislocation, which are mainly asymptomatic. Given the long interval between the original procedure and dislocation, especially in asymptomatic elderly patients presenting isolated pseudoexfoliation without dislocation, the benefits of surgery must be weighed against the risks, and close observation for minimal inferior dislocation is necessary. In our series, one patient who developed cystoid macular edema that may have been related to pseudophakodonesis underwent surgery, although no inferior displacement was noted. Thus, associated conditions other than the degree of decentration must be considered and could affect the decision on whether to operate.
The other patient with pseudophakodonesis classified as grade I presented slightly inferior dislocation. In the presence of any minimal degree of inferior dislocation, early surgery is strongly recommended.

A surgical approach is recommended whenever any dislocation, no matter how small, is detected. Complete dislocation in such cases is only a matter of time, and managing a completely dislocated capsular bag-IOL complex luxated into the vitreous cavity is more challenging and more complicated than managing a subluxated IOL.

Once surgical management is decided, the approach depends on the surgeon’s preferences and specialty and the clinical features of the individual case, including type of IOL and presence of CTR, stage and site of IOL dislocation, and coexisting ocular pathology. Surgical approaches include repositioning and replacement. Unlike out-of-the-bag IOL dislocation, sulcus repositioning without scleral suturing is precluded due to a lack of capsular support.

Repositioning is our preferred approach. The advantage of repositioning and suturing the IOL is that it does not require a large limbal incision, thus reducing trauma to the corneal endothelium and postsurgical astigmatism. Furthermore, the risk of expulsive hemorrhage is decreased; On the basis of our experience in the present series, repositioning can be accomplished in grade I and II dislocation, with open-loop lenses and plate-haptic lenses with holes or associated CTRs, and in cases with no excessive residual cortical material or advanced capsular shrinkage. Repositioning could also be considered in grade III dislocation, although in these cases surgical maneuvers are more difficult. Therefore, surgery should be performed once inferior dislocation is detected: replacement is avoided, and the surgical maneuvers for repositioning are easier.
Several techniques for repositioning and suturing a completely dislocated lens to the iris, sulcus, or pars plana have been described. Ab externo scleral fixation\textsuperscript{13} is a minimally invasive closed-system method of scleral fixation.

The IOL must be replaced in cases with grade III dislocation, damaged IOL or haptics, and presence of excessive residual cortical material. Another indication for replacement is in plate-haptic IOLs with no accompanying CTR or holes.

If the decision is taken to remove the entire IOL-capsule complex, the classic options for IOL replacement reported in the literature include angle-supported anterior chamber IOL (ACIOL) implantation, scleral fixation of posterior chamber IOL (SFIOL) and iris-suture of posterior chamber IOL (ISIOL).\textsuperscript{1-3, 6-11}

**OUTCOMES OF SURGICAL CORRECTION: 105 CASES**

A total of 105 cases of late in the bag IOL dislocation were identified. Four patients refused surgery to correct IOL position. In 49 cases the IOL-bag complex was repositioned by means of either *ab externo* SFIOL (48 cases) or iris fixation (1 case). In two cases, an anterior relaxing capsulotomy was performed. A decision to remove the capsular bag-IOL complex was made in the remaining 50, 20 of which had the IOL exchanged for an ICIOL, while 29 had the IOL exchanged by an ACIOL and one case was left aphakic. Regarding the cases that had the IOL exchanged for an ICIOL, 15 of them underwent prepupillar ICIOL implantation while 5 of them had retropupillar ICIOL fixation.

The IOL was repositioned using ab externo scleral fixation (SFIOL) in 48 eyes, and iris suturing in 1 eye. The IOL was replaced with an anterior chamber IOL (ACIOL) in 29 eyes, and with an iris-claw IOL (Artisan\textsuperscript{®}) (ICIOl) in 20 eyes. The Hoffman technique for scleral fixation was used in 1 eye. This modification for scleral fixation was tried
and abandoned in another eye due to a subconjunctival hemorrhage, and the same technique as in the remaining eyes was performed. One of the eyes (case 44) presented superior in-the-bag dislocation of a plate-haptic IOL with no associated capsular ring. CDVA was 20/25. Surgery would have required replacement; therefore, anterior relaxing capsulotomy was performed, with almost perfect resolution of the dislocation. Anterior relaxing capsulotomy was also performed in case 91. Posterior pars plana vitrectomy was performed in five cases with the IOL-bag complex completely dislocated into the vitreous cavity. One of these cases was left aphakic because of high myopia (case 52). Anterior vitrectomy was performed when necessary in the remaining cases using a biaxial limbal approach. Of note, the vitreous was too liquefied in all cases. Four patients refused surgery to correct IOL position.

The mean interval between cataract surgery and surgical correction of IOL position was 8.06 ± 3.30 years. Mean follow-up was 9.95 ± 10.49 months (range, 3 to 45 months).

**Postoperative visual acuity results**

Mean CDVA improved significantly after surgery (p=0.0001) (Figure 6). The mean preoperative logMAR CDVA (±SD) was 1.23 ± 0.95 (range of Snellen visual acuity, light perception to 20/20). Mean postoperative logMAR CDVA (± SD) was 0.41 ± 0.50 (range of Snellen visual acuity, light perception to 20/20). There were statistically significant differences in preoperative CDVA between the eyes that underwent IOL repositioning using scleral fixation and the eyes in which replacement was with an ACIOL (p=0.007) or an ICIOL (p=0.019). There were no statistically significant differences in postoperative CDVA between the eyes that underwent IOL repositioning using scleral fixation and the eyes in which replacement was with an ACIOL (p=0.753).
<table>
<thead>
<tr>
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<td><strong>N eyes</strong></td>
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<td>48</td>
<td>29</td>
<td>20</td>
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<td>Mean ± SD logMAR</td>
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<td>LP to 20/20</td>
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Complications

-IOL repositioning with scleral fixation

Intraoperative complications included 1 case of subconjunctival hemorrhage when the Hoffman technique was used for scleral fixation. Thus, this approach was aborted and the conventional technique was used. There were 5 cases of anterior vitreous hemorrhage and one case of hiphema, which resolved spontaneously within 1 month. Postoperative complications included one case of CME which resolved with topical anti-inflammatory agents and two cases of vitreous strands which were cut with YAG laser. In 1 case, excessive traction caused the IOL to dislocate in the opposite direction after surgery. Another suture was placed in the opposite haptic in a second procedure to correct the position. In two cases, the IOL-bag complex suffered tilt and secondary dislocation. Both cases were managed by IOL exchange for a ICIOL (cases 88 and 93).

-Exchange for an ACIOL

A planned replacement with an ACIOL was complicated by a choroidal hemorrhage. The choroidal hematoma was drained and anatomical resolution was achieved, although
the eye suffered from optic nerve atrophy with final vision of light perception only. An anterior vitreous hemorrhage resolved within one month.

Postoperative complications included pupillary block, which was observed in three cases and successfully treated with laser iridotomy, one case of CME which resolved under topical non-steroidal anti-inflammatory agents and two cases of vitreous strands treated with YAG laser.

-Exchange for an ICIOL

Postoperative complications included wound leak requiring resuturing (1 case), hyphema (1 case), transient IOP spike (2 case), asymptomatic pupil distorsion (2 cases) and wound leak that resolved spontaneously (1 case).

Subsequent procedures included three laser iridotomies, four YAG laser to cut anterior vitreous strands, trabeculectomy in two eyes, drainage of choroidal hematoma in one case, an additional procedure to place a second suture in the opposite haptic to correct IOL position in the case with excessive traction in the first suture, and two cases of IOL exchange for an ICIOL in the group of IOL repositioning with scleral fixation.
REFERENCES


