

Possible Predisposing Factors for Late Intraocular Lens Dislocation After Routine Cataract Surgery

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Key Words: late intraocular lens dislocation; pseudoexfoliation; cataract surgery.

Summary. *Objective.* The aim of this study was to evaluate possible risk factors for late intraocular lens (IOL) dislocation after routine cataract surgery.

Material and Methods. A retrospective analysis of medical records of all the patients who were treated in the university hospital between 2011 and 2012 for late IOL dislocation requiring surgical management after routine cataract surgery was performed. In total, 58 patients (58 eyes) were included into the study.

Results. The mean time between cataract surgery and late IOL dislocation was 67.8 months (SD, 34.9). A negative correlation was found between the patient age at cataract surgery and the time between cataract surgery and IOL dislocation ($r=-0.29$; $P=0.042$). Late in-the-bag dislocation occurred in 87.9% and late out-of-the-bag dislocation in 12.1% of the cases. Pseudoexfoliation was present in 56.9% and 42.9% of the eyes with in-the-bag and out-of-the-bag dislocation, respectively. The odds ratio for IOL dislocation within 43 months after complicated cataract surgery was 24.0 (95% confidence interval [95% CI] 4.5–127.4; $P<0.001$) and for in-the-bag IOL dislocation 24.9 (95% CI, 4.2–148.0; $P<0.001$). The odds ratio for in-the-bag IOL dislocation within 43 months after advanced cataract surgery was 18.8 (95% CI, 2.0–180.0; $P=0.011$). Moreover, in-the-bag IOL dislocation occurred earlier in the patients with past uveitis ($P=0.020$) or zonule laxity ($P=0.037$).

Conclusions. Complicated cataract surgery increased the risk of both late in-the-bag and out-of-the-bag IOL dislocation, and advanced cataract increased the risk of late in-the-bag IOL dislocation. The time to in-the-bag IOL dislocation shortens with pseudoexfoliation syndrome, advanced age, or past uveitis. These factors must be taken into account while planning a postoperative follow-up.

Introduction

Cataract surgery is a safe surgical procedure with a high rate of success and has markedly improved because of development in surgical devices and intraocular lenses (IOLs), making it safer than it was 20 years ago. The surgical complication rate is low: capsule rupture occurs in 1.9% to 5.2% and vitreous loss in 1.1% to 5.0% of cataract surgeries (1). In most cases, the visual prognosis is good with an anticipated postoperative increase in visual acuity.

IOL dislocation is one of the most serious complications after cataract surgery. The causes of IOL dislocation are loss of capsular or zonular integrity during surgery or asymmetric placement of the haptics (2). Most cases of IOL decentration present during the first weeks after cataract surgery with the incidence being between 0.2% and 2.8% (3). A zonular rupture is also believed to be a major cause of early IOL dislocation. The zonules may be damaged during cataract surgery due to posterior pressure on the lens or IOL implantation (4).

Late IOL dislocation has been reported with an

increasing frequency in recent years (2). Wider indications for cataract surgery along with an increased lifespan may result in an increased incidence of late IOL dislocations. Late IOL dislocation is a result of progressive capsular contraction and zonular dehiscence. The predisposing conditions such as pseudoexfoliation (PEX) syndrome, trauma, uveitis, previous vitrectomy, high axial length, and retinitis pigmentosa are present in approximately 90% of dislocation cases (2, 4, 5). Zonular dehiscence, fibrosis, and capsular shrinkage may further compromise the weakened zonules (2). The zonules also become more friable with age; unrecognized or subclinical zonular damage is presumed to occur during routine cataract surgery (6).

If the dislocation of the IOL causes visual symptoms or uncontrolled intraocular pressure (IOP), repositioning or exchange of the IOL is required. Different surgical procedures such as repositioning of the IOL within the bag, transscleral fixation of the IOL and the bag complex, or pars plana vitrectomy (PPV) with IOL explantation and exchange with an anterior chamber IOL are performed. All surgical manipulations are related to an increased risk of serious complications such as retinal tear, retinal detachment, and vitreous hemorrhage (2).

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The aim of this study was to evaluate possible risk factors for late in-the-bag and out-of-the-bag IOL dislocation after routine cataract surgery requiring surgical management.

Material and Methods

A retrospective analysis of the medical records of all the patients who developed late IOL dislocation requiring surgical management at the Clinic of Ophthalmology, Hospital of Lithuanian University of Health Sciences, between 2011 and 2012 was carried out. The patients were included into the study if late IOL dislocation was diagnosed 1 year or later after routine cataract surgery with endocapsular IOL implantation. The indications for surgery were visual symptoms or uncontrolled IOP.

The data on age, sex, ocular comorbidity, type of cataract (at the time of cataract surgery), PEX, IOP, time from cataract surgery to dislocation, implantation of a capsule tension ring (CTR), axial length, Nd:YAG laser capsulotomy or pars plana vitrectomy after cataract surgery, grade, type, and place of IOL dislocation, and other ocular findings due to IOL dislocation, as well as the type of the surgical procedure to manage IOL dislocation were reviewed.

Late in-the-bag IOL dislocation is graded as small, moderate, or total. In case of small dislocation, the IOL is centered; however, a gap is present between the pupillary margin and the IOL. Furthermore, pseudophakodonesis may be observed on the slit lamp examination. In case of moderate dislocation, the IOL is still observed in the pupillary area; however, it is decentered, and the reduction in patient's vision is caused by looking through the peripheral part of the optic. In case of total dislocation, the IOL is either not visible in the pupillary area or a tiny part of it is observed at the lower pupillary margin.

IOP higher than 21 mm Hg with a minimum difference of 5 mm Hg from the other eye was considered as hypertension due to IOL dislocation, if such a difference was not noted during a follow-up after cataract surgery.

The statistical analysis was performed using Statistical Package for the Social Sciences, version 19.0 (SPSS Inc, Chicago, Illinois). The assumption of normal distribution of continuous data was verified using the Kolmogorov-Smirnov test. When the distribution was normal, the mean differences between independent samples of the 2 groups were assessed using the Student *t* test. The Mann-Whitney test was used for nonparametric variables. A relationship between variables was analyzed using the Pearson correlation. Logistic regression analysis was employed to identify a significant association between the time from cataract surgery and IOL dislocation and possible risk factors for IOL dislocation. Receiver operating characteristic (ROC) curves for the time between cataract surgery and IOL dislocation

were created to analyze a discriminating ability of possible contributing factors. *P* values less than 0.05 were considered significant.

Results

In total, 58 eyes of 58 patients were included into the study. The mean age at the time of IOL dislocation was 72 years (SD, 10.9 years; range, 27 to 90). The mean age at cataract surgery was 67 years (SD, 10.5; range, 18 to 88). The mean axial length of all the eyes was 24.14 mm (SD, 1.8) with the range from 21.6 to 30.4 mm. At the time of cataract surgery, 51 eyes (87.9%) were with early and immature cataract and 7 (12.1%) with advanced and mature cataract. The prevalence of ocular comorbidity was 63.8% (37 eyes). In most of the patients, phacoemulsification with IOL implantation was performed. The patients' characteristics and preoperative data are described in Table 1.

Late in-the-bag IOL dislocation was found in 87.9% and late out-of-the-bag IOL dislocation in 12.1% of the reviewed cases. The possible risk factors for late IOL dislocation are listed in Table 2.

Table 1. Patients' Characteristics and Preoperative Data (n=58)

Characteristic	Value
Gender	
Men	39 (67.2)
Women	19 (32.8)
Age, mean (SD), years	
At cataract surgery	67 (10.5)
At IOL dislocation	72 (10.9)
Lens maturity at cataract surgery	
Early or immature cataract	51 (87.9)
Advanced or mature cataract	7 (12.1)
Type of cataract surgery	
Phacoemulsification	56 (96.5)
Extracapsular cataract extraction	2 (3.5)
Ocular comorbidity	
Glaucoma	21 (36.2)
Age-related macular degeneration	12 (20.7)
Myopia	10 (17.2)
Uveitis before cataract surgery	3 (5.2)
Other*	9 (15.5)

Values are number (percentage) unless otherwise indicated. IOL, intraocular lens.

*3 cases of optic nerve atrophy, 2 cases of diabetic retinopathy, 2 cases of preretinal fibrosis, 1 case of retinitis pigmentosa, and 1 case of a macular hole.

Table 2. Possible Risk Factors for Late IOL Dislocation

Factor	In-the-Bag Dislocation Group (n=51)	Out-of-the-Bag Dislocation Group (n=7)
Pseudoexfoliation	29 (56.9)	3 (42.9)
Zonular laxity during cataract surgery	18 (35.3)	0 (0)
CTR implantation	15 (29.4)	0 (0)
Trauma	11 (21.6)	2 (28.6)
Complications of cataract surgery	10 (19.6)	4 (57.1)

Values are number (percentage). CTR, capsule tension ring.

The leading possible risk factors for in-the-bag dislocation were pseudoexfoliation (29 eyes, 56.9%), zonular laxity during cataract surgery (18 eyes, 35.3%), and CTR implantation (15 eyes, 29.4%). The leading factor for late out-of-the-bag dislocation was complications of cataract surgery noted in 57.1% of the eyes of the out-of-the-bag group.

IOL dislocation occurred after 67.8 months on the average (SD, 34.9; range, 12 to 180; median, 60.0). Out-of-the-bag and in-the-bag dislocations occurred after 95.9 months (SD, 51.5; range, 25 to 180; median, 96.0) and 64.0 months (SD, 30.8; range, 12 to 144; median, 64.0), respectively.

Further statistical analysis was performed only in the cases with in-the-bag IOL dislocation. There was a significant negative correlation between the patient's age at cataract surgery and the time between cataract surgery and IOL dislocation (Pearson correlation coefficient, $r = -0.29$; $P = 0.042$) (Fig.).

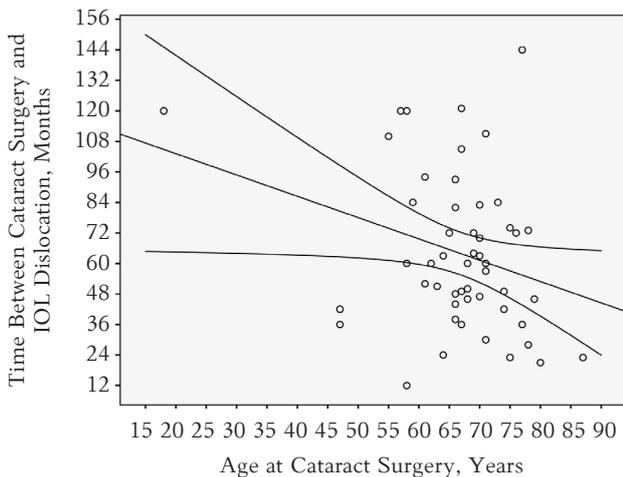


Fig. Correlation between age and time from cataract surgery to in-the-bag IOL dislocation with 95% confidence interval

A significantly shorter time to dislocation was found in the patients with uveitis before cataract surgery ($P = 0.020$), advanced or mature cataract ($P = 0.044$), zonule laxity ($P = 0.037$), or complications during cataract surgery ($P = 0.033$). There was a significant difference in the prevalence of complications comparing advanced or mature cataract surgery with early and immature cataract surgery (50.0% and 15.6%, $P = 0.046$). The complications of cataract surgery included capsular ruptures and vitreous loss (5 eyes, 9.8%).

The optimal time from cataract surgery to IOL dislocation of 43 months was found using the ROC curve (sensitivity, 0.7; specificity, 0.9; area under curve, 80%). IOL dislocation regardless of the type and in-the-bag dislocation was more likely to occur within 43 months after complicated than uncomplicated cataract surgery (odds ratio [OR], 24.0; 95% confidence interval [CI], 4.5–127.4; $P < 0.001$, and OR, 24.9; 95% CI, 4.2–148.0; $P < 0.001$, respectively). The odds ratio for in-the-bag IOL dislocation within 43 months after surgery for advanced or mature cataract was 18.8 (95% CI, 2.0–180.0; $P = 0.011$).

Table 3 shows the prevalence of all possible predisposing factors for late in-the-bag IOL dislocation and the time from cataract surgery to IOL dislocation in the cases with and without these factors.

PEX syndrome was the most frequent possible predisposing factor for late in-the-bag IOL dislocation (29 cases, 56.9%). The data on demographic characteristics, cataract surgery, IOL implantation, and dislocation with regard to PEX syndrome are summarized in Table 4. The time to in-the-bag IOL dislocation in the PEX group was shorter, i.e., 63.1 months (SD, 29.4), but not significantly. The patients with PEX were significantly older at the time of cataract surgery than those without PEX (mean

Table 3. Prevalence of All Possible Predisposing Factors for Late in-the-Bag IOL Dislocation and Time from Cataract Surgery to Dislocation in Cases With and Without These Factors (n=51)

Factor	n (%)	Time Between Cataract Surgery and IOL Dislocation, mean (SD), months		P Value
		With Factor	Without Factor	
Pseudoexfoliation	29 (56.9)	63.1 (29.4)	65.1 (33.2)	0.824
Myopia	9 (17.6)	54.1 (30.1)	75.0 (33.4)†	0.099*
Uveitis before cataract surgery	3 (5.9)	35.3 (7.0)	81.2 (24.9)†	0.020*
Trauma as a cause of dislocation	11 (21.6)	68.0 (36.4)	62.9 (29.5)	0.675
History of trauma	2 (3.9)	44.0 (28.3)	65.3 (15.1)†	0.355*
Pars plana vitrectomy after cataract surgery	1 (2.0)	72	71.0 (15.6)†	0.988*
Trabeculectomy after cataract surgery	1 (2.0)	121	66.5 (21.9)†	0.221*
Nd:YAG capsulotomy after cataract surgery	7 (13.7)	64.4 (39.6)	66.7 (22.9)†	0.765*
Complications of cataract surgery	10 (19.6)	44.2 (32.5)	60.8 (24.9)†	0.033*
Zonule laxity during cataract surgery	18 (35.3)	52.1 (28.4)	70.5 (30.4)	0.037
CTR implantation	15 (29.4)	53.0 (27.6)	68.6 (31.2)	0.088
Long axis (≥ 26 mm)	6 (11.8)	61.3 (32.1)	60.5 (24.8)†	0.814*
Advanced and mature cataract	6 (11.8)	36.0 (19.9)	60.8 (24.9)†	0.044*
No identifiable factors	5 (9.8)	75.0 (21.7)	52.9 (14.5)†	0.143*

*Mann-Whitney U Test; †data on randomized groups (ratio 1:2).

Table 4. Demographics, Cataract Surgery Data, and in-the-Bag IOL Dislocation With Regard to Pseudoexfoliation Syndrome

Characteristic	Total n=51	PEX+ n=29	PEX- n=22	P Value
Age at IOL dislocation, mean (SD), years	72 (10.4)	75 (9.3)	68 (11.0)	0.036
Sex				
Men	36 (70.6)	22 (75.9)	14 (63.6)	0.344
Women	15 (29.4)	7 (24.1)	8 (36.4)	
Axial length, mean (SD), mm	24.19 (1.93)	23.58 (1.16)	24.79 (2.34)	0.040
Open-angle glaucoma	20 (39.2)	17 (58.6)	3 (13.6)	0.001
Degree of cataract				
Advanced and mature cataract	6 (11.8)	3 (10.3)	3 (13.6)	0.719
Early and immature cataract	45 (88.2)	26 (89.7)	19 (86.4)	
Type of cataract surgery, n (%)				
Phacoemulsification	49 (96.1)	28 (96.6)	21 (95.5)	0.842
Extracapsular cataract extraction	2 (3.9)	1 (3.4)	1 (4.5)	
Zonule laxity during cataract surgery	18 (35.3)	9 (31.0)	9 (40.9)	0.466
CTR implantation	15 (25.9)	10 (31.3)	5 (19.2)	0.299
Complications of cataract surgery	10 (19.6)	7 (24.1)	3 (13.6)	0.342
Nd:YAG capsulotomy	7 (13.7)	6 (20.7)	1 (4.5)	0.097
Grade of IOL dislocation				
Small	9 (17.6)	8 (27.6)	1 (4.5)	0.363
Moderate	29 (56.9)	15 (51.7)	14 (63.7)	
Total	13 (25.5)	6 (20.7)	7 (31.8)	
Place of IOL dislocation				
At IOL plane, inferior	36 (70.6)	22 (75.9)	14 (63.7)	0.797
At IOL plane, superior	2 (3.9)	1 (3.4)	1 (4.5)	
Vitreous cavity	13 (25.5)	6 (20.7)	7 (31.8)	
IOP with IOL dislocation, mean (SD), mm Hg	20.44 (9.57)	20.14 (9.76)	20.81 (9.53)	0.807
Complications due to IOL dislocation	21 (41.2)	13 (44.8)	8 (36.4)	0.542

Values are number (percentage) unless otherwise stated.

IOP, intraocular pressure; IOL, intraocular lens; CTR, capsule tension ring.

age, 69 [SD, 8.7] and 63 years [SD, 11.9], respectively; $P=0.038$). The prevalence of open-angle glaucoma was higher in the PEX than non-PEX group (58.6% vs. 13.6% $P=0.001$). After cataract surgery, 6 PEX eyes (20.7%) and 1 non-PEX eye (4.5%) necessitated Nd:YAG capsulotomy ($P=0.097$), and 2 eyes with PEX developed IOL dislocation straight after capsulotomy. The mean axial length of the non-PEX eyes was significantly greater than in the eyes with PEX (24.79 and 23.58 mm, respectively; $P=0.040$).

The findings at the time of in-the-bag IOL dislocation are listed in Table 4. Thirty-six (70.6%) IOL dislocations were downward at the IOL plane, 2 (3.9%) upward at the IOL plane, and 13 (25.5%) to the vitreous cavity. The mean IOP of the eyes with IOL dislocation was 20.44 mm Hg (SD, 9.57; range, 5.3 to 41.5 mm Hg), and it was significantly higher than in the other eye, i.e., 15.96 mm Hg (SD, 4.56; range, 4.0 to 26.6 mm Hg) ($P=0.016$). The mean difference in the IOP between the eye with IOL dislocation and another eye was 4.36 mm Hg ($P=0.001$). The complications due to IOL dislocation included hypertension (13 eyes, 25.5%), vitreous prolapse into the anterior chamber (3 eyes, 5.9%), cornea decompensation (3 eyes, 5.9%), retinal tear with-

out detachment (1 eye, 2.0%), retinal detachment (1 eye, 2.0%), choroidal and retinal detachment (1 eye, 2.0%), and hypotony of 5.3 mm Hg (1 eye, 2.0%). Uveitis-glaucoma-hyphema syndrome was diagnosed in 4 cases (7.8%).

Surgical treatment of in-the-bag IOL dislocation was performed by employing pars plana vitrectomy along with a dislocated IOL exchange with anterior chamber IOL in the majority of the cases (45 eyes, 88.2%), IOL removal in 3 cases (5.9%), and IOL repositioning with fixation to the iris in 2 eyes (3.9%).

Discussion

Posterior chamber IOL dislocation or decentration is a well-known complication of cataract surgery and usually occurs when the integrity of the posterior or the equatorial capsule is disturbed. Most cases of early IOL dislocation happen during the first week after cataract surgery (2). Late IOL dislocation is defined as occurring 3 months or later after cataract surgery and has been reported with an increasing frequency in recent years (2). The study by Hayashi et al. that the possible predisposing factors were the complications of cataract surgery for out-of-the bag dislocation, and secondary implantation, posterior capsule rupture, mature cataract, and

PEX for late out-of-the bag IOL dislocation (7). In our study, late out-of-the-bag dislocation was found only in 7 cases (12%), and they were mostly in the eyes with complications during cataract surgery.

A great majority of all our study patients were diagnosed with late in-the-bag IOL dislocation. The incidence of 0.6% of late in-the-bag dislocation that requires surgery after 10 years with a 1% cumulative incidence over 10 years is reported; 40% of patients have pseudoexfoliation syndrome (8). Gross et al. hypothesized that there were 2 factors that contributed to in-the-bag dislocation: zonular weakness and contraction of the capsular bag (4). These factors can result in zonular failure and dislocation of the intact capsular bag. Some degree of contraction of the capsular bag may be present after cataract surgery. When capsular shrinkage is extreme, it is called capsular contraction syndrome. Such contraction results in additional stress on the potentially weakened zonules (4). The risk of a previously mentioned syndrome appears to be increased in eyes with pseudoexfoliation, uveitis, advanced age, and retinitis pigmentosa (9). Trauma may also cause a rupture of the zonules with IOL dislocation, i.e., the capsular bag to the vitreous cavity (4).

In our study, the possible predisposing factors for late in-the-bag IOL dislocation were PEX syndrome, zonular laxity at the time of cataract surgery, implantation of a CTR (possible zonular dialysis or zonular instability), trauma, and complications of cataract surgery. These possible predisposing factors were similar to those reported previously (2, 4, 7).

The dislocation of a natural lens in patients with PEX is a widely recognized condition. A natural lens can be dislocated either spontaneously or intraoperatively (10). The pseudoexfoliative material has been shown to disrupt the zonules at 3 levels: 1) at the origin of the ciliary body where they are anchored; 2) in the pars plicata of the ciliary body where they pass alongside the ciliary processes; and 3) at their attachment to the anterior lens capsule (11). The contributory factors leading to further disruption include an increased friability and a decreased tensile strength of the zonules. In such cases, even after endocapsular IOL implantation, immediate postoperative IOL dislocation or late decentration can occur. This finding is attributed to decentration of the entire capsular bag because of zonular weakness and damage (12).

The mean time from cataract surgery to in-the-bag IOL dislocation in our study was 64 months (5.5 years), which was shorter than in other studies, i.e., 6.5 years (13) and 6.9 years (4). In the study by Davis et al., the mean time from the first to the second surgery was 8.5 years (6). Therefore, there could be factors related to shorter intervals between the surgeries. Jakobsson et al. found that older age at cataract surgery and zonular dehiscence were sig-

nificantly associated with a shorter time (13). We found a significantly shorter interval in the eyes with a history of uveitis, zonular laxity, cataract surgery complications, and advanced or mature cataracts. We also found a negative correlation between the age at cataract surgery and the time to dislocated IOL surgery. All these factors may increase the risk of capsular contraction and zonular weakness (4, 9, 10).

Though the presence of PEX did not shorten the period from cataract surgery to IOL dislocation significantly, the high prevalence of PEX in our study suggests it as a risk factor for late dislocation. The time to IOL dislocation in the PEX and the non-PEX eyes was 63.1 months (SD, 29.6) and 65.1 months (SD, 33.2), respectively. The same was found by Jakobsson et al. (13). The analysis of the factors in the groups of the eyes with and without PEX revealed some significant differences: the patients with PEX were older; they had a higher prevalence of glaucoma and a shorter axial length. According to the latter finding, we could suspect a longer axis to be a factor associated with late in-the-bag dislocation in eyes without PEX.

A CTR is used as an intraoperative support tool during cataract surgery and as a long-term implant device for postoperative IOL fixation. The common indications include PEX, traumatic or iatrogenic zonular damage, hypermature cataracts, and prior vitrectomy and filtration surgery (14, 15). Not all the cases with zonular instability can be managed with a CTR alone (15). In our study, a CTR was implanted in 31.3% of the PEX patients and in 19.2% of the non-PEX patients with in-the-bag IOL dislocation (the difference was insignificant). Therefore, CTR implantation in particular cases can lead to the implication of an increased zonular instability or dehiscence at the time of cataract surgery with no long-term beneficial support.

The management of dislocated IOL depends on clinical signs and surgeon's preference. The management options described for dislocated posterior chamber IOLs include IOL repositioning with or without scleral fixation sutures (depending on residual capsular support) and IOL removal (with or without reimplantation of the same or alternative IOL). A dislocated posterior chamber IOL can be changed to a sutured posterior chamber IOL or an anterior chamber IOL (16). In our study, most of the eyes were treated by posterior chamber IOL exchange with an anterior chamber IOL being dependent on our surgeons' preference.

Conclusions

Late IOL dislocation after routine cataract surgery was mostly of the in-the-bag type. Complicated cataract surgery (insufficient capsular support for IOL) increased the risk of both late in-the-bag

and out-of-the-bag IOL dislocation, and advanced cataract increased the risk of late in-the-bag IOL dislocation. Patients with pseudoexfoliation syndrome, advanced age, or after uveitis also may be at risk of delayed spontaneous IOL dislocation within the capsular bag after uncomplicated cataract surgery due to an increased risk of zonular dehiscence,

which is exacerbated by postoperative capsular fibrosis. These factors must be taken into account while planning a postoperative follow-up of patients at higher risk.

Statement of Conflict of Interest

The authors state no conflict of interest.

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