Capsular tension ring implantation after capsulorhexis in phacoemulsification of cataracts associated with pseudoexfoliation syndrome

Intraoperative complications and early postoperative findings

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ABSTRACT

Purpose: To evaluate the effect of an endocapsular tension ring in preventing zonular complications during phacoemulsification of cataracts associated with pseudoexfoliation syndrome.

Setting: Eye Clinic of Beyoğlu Education and Research Hospital, Istanbul, Turkey.

Methods: A prospective randomized study comprised 78 eyes with cataract and pseudoexfoliation syndrome that were randomly divided into 2 groups. The age, sex, cataract density, iridodonesis, axial length, anterior chamber depth, best corrected visual acuity (BCVA), and intraocular pressure (IOP) were matched between groups. In 39 eyes, a capsular tension ring (CTR) was implanted after capsulorhexis and hydrodissection but before nucleus emulsification. Thirty-nine eyes that did not have a CTR implanted served as a control. The main outcome measures were the rates of intraoperative zonular separation and capsular fixation of a foldable intraocular lens (IOL). Posterior capsule rupture without zonular dialysis, vitreous loss, corneal edema, fibrin in the anterior chamber, BCVA, and IOP in the immediate postoperative period were also compared between the 2 groups.

Results: Five eyes (12.8%) in the control group and no eye in the CTR group had intraoperative zonular separation ($P = .02$). Posterior capsule rupture without zonular separation occurred in 3 eyes (7.7%) in the control group and 2 (5.2%) in the CTR group. Capsular IOL fixation was achieved in 37 eyes (94.9%) in the CTR group and 31 eyes (74.3%) in the control group ($P = .012$). The difference in BCVA was not statistically significant between the 2 groups ($P = .44$); however, uncorrected visual acuity (UCVA) was significantly better in the CTR group ($P = .026$).

Conclusion: In cases of cataract associated with pseudoexfoliation syndrome, implanting a CTR before phacoemulsification of the nucleus reduced intraoperative zonular separation, increased the rate of capsular IOL fixation, and improved UCVA. *J Cataract Refract Surg 2001; 27:1620–1628 © 2001 ASCRS and ESCRS*

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Cataract surgery in the presence of pseudoexfoliation syndrome has been associated with an increased incidence of intraoperative complications.[1–17] In pseudoexfoliation syndrome, lysosomal proteinases destroy the normal basement membrane structure of the nonpigmented epithelium of the ciliary body and anterior lens capsule.[18,19] The breakdown of the basement membrane structure loosens the zonule–lens capsule complex and causes adhesions between the zonules and nonpigmented epithelium.[18,19] The rotational and anterior–posterior forces created during nucleus emulsification may lead to total separation of these weakened zonules, resulting in vitreous loss. Other factors thought to contribute to the increased incidence of intraoperative complications during cataract surgery in eyes with pseudoexfoliation syndrome are poorly dilating pupils, corneal endothelial changes, and blood–aqueous barrier (BAB) breakdown.[20–25]

In this study, we evaluated the effect of implanting a capsular tension ring (CTR) after capsulorhexis and hydrodissection on intraoperative complications resulting from zonular weakness during phacoemulsification of the cataract associated with pseudoexfoliation syndrome.

Patients and Methods

This prospective randomized study comprised 78 eyes diagnosed as having cataract associated with pseudoexfoliation syndrome that had cataract surgery between August 1998 and January 2000. Patients were randomly assigned to 1 of 2 groups. Thirty-nine eyes had a CTR implanted after capsulorhexis and hydrodissection were performed but before phacoemulsification was started. The other 39 eyes had no CTR and served as a control group.

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Table 1 shows the patients' characteristics. There were no statistically significant differences difference between the 2 groups in age, sex, right or left eye, cataract density, evidence of iridodonesis, miotic pupils, axial length, anterior chamber depth (ACD), best corrected visual acuity (BCVA), presence of coexisting glaucoma, intraocular pressure (IOP), and number of glaucoma medications. Most nuclei in both groups were grade 2 or 3; 14 eyes in the CTR group and 10 in the control group had white mature cataract ($P = .33$).

Eyes with uncontrolled glaucoma that had combined surgery were not enrolled in this study. However, 17 patients (21.7%) with medically controlled mild or moderate glaucoma and 5 (6.4%) with previous filtering surgery and controlled glaucoma were enrolled; 12 of the eyes (30.8%) were in the CTR group and 10 (25.6%) in the control group. Eyes with advanced glaucoma with compromised optic discs, exudative age-related macular degeneration, diabetic retinopathy, or other disease that would result in low postoperative BCVA were excluded from the study.

The mean preoperative IOP was 15.2 mm Hg ± 5.5 (SD) in the CTR group and 15.1 ± 3.7 mm Hg in the control group ($P = .96$). The mean number of glaucoma medications was 0.23 ± 0.54 and 0.26 ± 0.55, respectively ($P = .95$).

Preoperatively, a dilated fundus examination was performed except in eyes with very dense or white cataract.

All operations were performed by 1 of 2 experienced surgeons. Surgeon 1 (Ş.B.) performed surgery in 34 eyes (19 with a CTR), and surgeon 2 (Ö.F.Y.) operated on 44 eyes (20 with a CTR) There was no statistically significant difference between the percentage of eyes operated on by each surgeon or the percentage of eyes implanted with a CTR ($P = .25$, chi-square test).

Surgical Technique

After sub-Tenon's or topical anesthesia was administered, a 3.2 mm temporal clear corneal incision was made with a diamond knife. The anterior chamber was filled with sodium hyaluronate 3.0%-chondroitin sulfate 4.0% (Viscoat®). In eyes with poor pharmacological pupil dilation, a Beehler dilator or iris hooks were used to enlarge the pupil. Capsulorhexis was performed with a Utrata forceps. In eyes with mature cataract, trypan blue vital dye staining was used to visualize the anterior

Table 1. Preoperative patient characteristics.

Characteristic	Group		*P* Value
	CTR (n = 39)	Control (n = 39)	
Mean age (years)	73.7 ± 5.4	71.5 ± 8.1	.16
Sex, n (%)			.17
Male	21 (53.8)	15 (38.4)	
Female	18 (46.2)	24 (61.6)	
Eye, n (%)			.82
Right	18 (46.1)	20 (51.2)	
Left	21 (53.9)	19 (48.8)	
Nucleus, n (%)			.17
Grade 1	3 (7.7)	0	
Grade 2	15 (38.4)	21 (53.8)	
Grade 3	7 (17.9)	8 (20.6)	
Grade 4	1 (2.6)	0	
Mature cataract, n (%)	13 (33.4)	10 (25.6)	
Preoperative iridodonesis, n (%)			.76
Yes	7 (17.9)	5 (12.8)	
No	32 (82.1)	34 (87.2)	
Miotic pupil*, n (%)	17 (43.6)	14 (35.9)	.58
Mean axial length (mm)	23.1 ± 1.6	23.0 ± 1.8	.63
Mean ACD (mm)	2.55 ± 0.46	2.74 ± 0.42	.14
Mean BCVA (Snellen)	20/180 ± 135	20/165 ± 120	.83
Coexisting glaucoma, n (%)	12 (30.8)	10 (25.6)	.80
Mean IOP (mm/Hg)	15.2 ± 5.5	15.1 ± 3.7	.96
Mean number of glaucoma medications	0.23 ± 0.54	0.26 ± 0.55	.95

All means ± SD
CTR = capsular tension ring; ACD = anterior chamber depth; BCVA = best corrected visual acuity; IOP = intraocular pressure
*Pupils 4.0 mm or smaller after full dilation

lens capsule. All capsulocortical attachments were loosened by careful, thorough hydrodissection. Then, an Ophtec or Morcher CTR was implanted under the capsulorhexis edge with a forceps (Figure 1). In eyes with axial lengths longer than 25.0 mm (n = 2), a 13.0 mm CTR was implanted. In the other eyes, a 12.0 or 11.0 mm CTR was used.

Phacoemulsification was performed using a stop-and-chop technique in all cases. After the cortex was removed, the capsular bag was filled with sodium hyaluronate 1% (Healon®). Then, a foldable hydrophobic acrylic intraocular lens (IOL) (AcrySof®) was implanted in the bag in uneventful cases. In cases with posterior capsule rupture without zonular dialysis, an AcrySof IOL was implanted in the sulcus after anterior vitrectomy.

Outcome Parameters

The primary outcome measures were the rate of intraoperative zonular separation (zonular dialysis, lens drop into the vitreous, phakodonesis with vitreous presentation) and in-the-bag fixation of a foldable IOL. Other parameters included posterior capsule rupture without zonular separation, vitreous loss, postoperative corneal edema, fibrin reaction in the anterior chamber, uncorrected visual acuity (UCVA), BCVA, IOP, num-

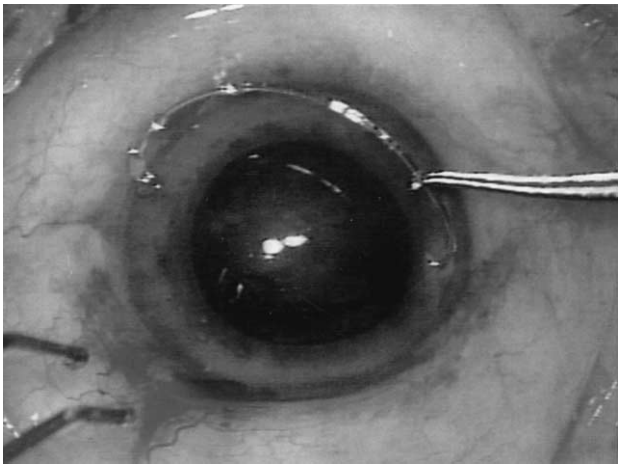

Figure 1. (Bayraktar) A CTR is inserted after capsulorhexis and hydrodissection.

ber of glaucoma medications, and transient IOP spikes in the early postoperative period.

Intraoperative zonular separation was defined as zonular dialysis of at least 90 degrees with or without lens drop into the vitreous cavity and conversion to intracapsular cataract extraction (ICCE). To evaluate the influence of the surgeon factor, the intraoperative zonular complication rates of the 2 surgeons were compared.

The exact IOL placement was verified by intraoperative assessment and a postoperative biomicroscopic examination performed through a dilated pupil. Placement was classified as bag, sulcus, fixated to the sclera, anterior chamber, or null.

Corneal edema, defined as striate keratitis with or without accompanying stromal thickening in the early postoperative period, was graded on a 4-point scale: 0 = no edema; 1 = minimal corneal striae and edema with no reduction in visual acuity; 2 = mild corneal edema with reduction in visual acuity; 3 = moderate corneal edema with reduction in visual acuity; 4 = severe corneal edema with reduction in visual acuity.

Fibrin in the anterior segment was determined by a biomicroscopic examination 1 day postoperatively.

Intraocular pressure was measured by applanation tonometry at all visits. When the IOP at the first postoperative examination was higher than 25 mm Hg but returned to a normal level (≤17 mm Hg), the diagnosis was a transient IOP spike. The preoperative and the last postoperative IOPs in the CTR and control groups were compared. A similar comparison was done for the number of glaucoma medications.

Statistical Analysis

For averaging, visual acuities (Snellen at 6 meters) were converted to logMAR values. The calculated mean logMAR acuities were then reconverted to the Snellen scale. The best UCVA and BCVA in each patient throughout the follow-up were used for group comparisons. The predictors of BCVA were also analyzed by univariate and multivariate regression analysis.

Statistical comparisons were done using the SPSS software for Windows (release 7.0). A chi-square test was used to compare proportions or percentages and the Student *t* test, to compare numerical values. A *P* value less than 0.05 was considered statistically significant.

Results

Intraoperative Zonular Complications

No eye in the CTR group had zonular separation during surgery. In the control group, zonular complications occurred in 5 eyes (12.8%) (Table 2). The rate of intraoperative zonular complications was statistically significantly different between the 2 groups ($P = .021$).

The zonular complication rate was not statistically significant between the 2 surgeons ($P = .87$, chi-square test). Surgeon 1 had 2 eyes with zonular complications and surgeon 2, 3 eyes.

Intraocular Lens Fixation

In-the-bag fixation of a foldable IOL was achieved in 37 eyes (94.9%) in the CTR group and 31 eyes (79.5%) in the control group (Table 3). The rate of

Table 2. Intraoperative complications.

Complication	Group, n (%)		*P* Value
	CTR (n = 39)	Control (n = 39)	
Zonular separation	0	5 (12.8)	.02*
Whole lens dropped into vitreous	0	2 (5.1)	.24
Conversion to ICCE	0	2 (5.1)	.24
Zonular dialysis during IOL implantation	0	1 (2.6)	.02
Posterior capsule perforation without zonular separation	2 (5.1)	3 (7.7)	.24
Anterior vitrectomy	2 (5.1)	8 (20.5)	.01*

CTR = capsular tension ring; ICCE = intracapsular cataract extraction; IOL = intraocular lens
*Statistically significant

Table 3. Intraocular lens fixation.

Fixation Site	Group		*P* Value
	CTR (n = 39)	Control (n = 39)	
In the capsular bag	37 (94.9)	31 (79.5)	.01*
In the sulcus	2 (5.1)	3 (7.7)	—
Scleral (secondary)	0	2 (5.1)	—
Anterior chamber	0	1 (2.6)	—
No IOL implanted (left aphakic)	0	1 (2.6)	—
Secondary CTR, implanted in the bag	0	1 (2.6)	—

CTR = capsular tension ring; IOL = intraocular lens
*Statistically significant

capsular fixation was statistically significantly different between groups ($P = .01$).

In the CTR group, 2 eyes (5.1%) with posterior capsule rupture without zonular separation had implantation of a 6.0 mm optic, 13.0 mm diameter foldable acrylic IOL in the sulcus after anterior vitrectomy. In the 3 eyes (7.7%) in the control group in which the posterior capsule ruptured without zonular dialysis, a foldable acrylic IOL was implanted in the sulcus after anterior vitrectomy. The rate of posterior capsule rupture without zonular separation was not statistically significantly different between groups ($P = .23$).

In 2 eyes in the control group, surgery was converted to ICCE because of extensive intraoperative zonular dialysis and secondary scleral fixation was performed. The whole lens dropped into the vitreous cavity in 2 control eyes; 1 was left aphakic, and the other received an anterior chamber IOL. In the 1 control eye in which zonular dialysis occurred during IOL implantation, a foldable acrylic IOL was implanted in the capsular bag after anterior vitrectomy and secondary CTR implantation were performed.

Other Parameters

The mean follow-up was 44.7 ± 92.9 days in the CTR group and 50.8 ± 47.8 days in the control group. The difference between groups was not statistically significant ($P = .71$).

One day postoperatively, corneal edema reducing visual acuity was present in 14 eyes (35.9%) in the CTR group and 12 eyes (30.8%) in the control group. The difference was not statistically significant ($P = .77$). Corneal edema resolved in 2 to 15 days in all eyes.

Postoperative fibrin reaction in the anterior chamber was seen in 3 eyes (7.7%) in the CTR group and in 7 eyes (17.9%) in the control group. The difference between groups was not statistically significant ($P = .17$). Intensive topical corticosteroid therapy dissolved the membrane without sequela in all cases.

Postoperatively, the mean BCVA was not statistically significantly different between groups ($P = .44$) However, the mean UCVA was statistically significantly better in the CTR group than in the control group ($P = .026$) (Table 4).

The univariate analysis showed that preoperative BCVA ($r = 0.29$, $P = .011$), preoperative ACD ($r = 0.36$, $P = .02$), and capsular IOL fixation ($r = 0.29$, $P = .009$) were positively related to postoperative BCVA. Patient age ($r = -0.25$, $P = .03$), intraoperative zonular separation ($r = -0.28$, $P = .014$), anterior vitrectomy ($r = -0.29$, $P = .009$), fibrin in the anterior chamber ($r = -0.23$, $P = .044$), and corneal edema ($r = -0.39$, $P = .0001$) were inversely related.

The multivariate regression analysis showed that the principal determinant of postoperative BCVA was patient age ($r = -0.50$, $r^2 = 0.25$, $P = .001$). When patient age was excluded from the analysis, the single statistically significant predictor was preoperative ACD ($r = 0.36$, $r^2 = 0.13$, $P = .02$).

During the first postoperative examination, transient IOP spikes were observed in 16 eyes in the control group and 8 eyes in the CTR group. The difference was statistically significant ($P = .03$). At the last follow-up visit, the mean IOP was significantly lower than preoperatively in both groups ($P = .025$, CTR; $P = .037$, control) (Table 4).

The mean number of glaucoma medications was less than preoperatively in the CTR group and the same in the control group, with no significant differences over time (Table 4).

Discussion

Cataract surgery is generally considered to be a challenge and associated with an increased incidence of complications in eyes with pseudoexfoliation syndrome.[1–17] The risks were first described for planned extracapsular cataract extraction (ECCE)[1–11] and later for phacoemulsification surgery.[11–17] Pseudoexfoliation syndrome is reported to be associated with an increased incidence of glaucoma (both open angle and angle clo-

Table 4. Postoperative findings.

Finding	Group		*P* Value
	CTR (n = 39)	Control (n = 39)	
Corneal edema, n (%)			.77
Grade 0	12 (30.8)	13 (33.3)	
Grade 1	13 (33.3)	14 (35.9)	—
Grade 2	10 (25.6)	9 (23.1)	—
Grade 3	4 (10.3)	2 (5.1)	—
Grade 4	0	1 (2.6)	—
Fibrin reaction, n (%)	3 (7.7)	7 (17.9)	.18
Mean UCVA (Snellen)	20/35 ± 75	20/55 ± 70	.03*
Mean BCVA (Snellen)	20/30 ± 75	20/33 ± 65	.44
IOP	13.5 ± 2.9	14.8 ± 3.8	.09*
Mean number of glaucoma medications	0.16 ± 0.37	0.26 ± 0.55	.41
Transient IOP spikes, n (%)	8 (20.5)	16 (41)	.03*

All means ± SD
CTR = capsular tension ring; UCVA = uncorrected visual acuity; BCVA = best corrected visual acuity; IOP = intraocular pressure
*Statistically significant

sure), cataract, phakodonesis caused by alterations of the zonular apparatus, BAB breakdown, anterior chamber hypoxia, poor pupil dilation, and early diffuse corneal endothelial decompensation resulting from decreased endothelial cell counts.[19–25] These factors are believed to increase the rate of intraoperative zonular separation, vitreous loss, postoperative IOP spikes, corneal edema, and fibrin reaction in the anterior chamber; affect the site of IOL placement; and reduce postoperative visual acuity.[19–23]

Capsular tension ring implantation was first described by Legler and Witschel[26] in 1993. When the poly(methyl methacrylate) ring is inserted in the capsular bag, it stretches the capsule equator and distributes the forces equally over all zonules.[26–32] In the regions in which zonular support is absent or inadequate, the ring supports the capsular bag and facilitates surgery. The CTR helps prevent postoperative IOL decentration in eyes with zonular dialysis up to 6 clock hours.[30] The 2 recommended indications for CTR implantation are zonular rupture or dehiscence after blunt or surgical trauma and inherent zonular weakness such as in cases of pseudoexfoliation, Marfan's syndrome, Weill-Marchesani syndrome, and long-standing silicone tamponade in vitrectomized eyes.[32]

Capsular tension rings may be inserted at any time during cataract surgery to maintain or reestablish the capsular diaphragm.[32] In the current study, we evaluated the prophylactic use of CTRs in eyes with pseudoexfoliation syndrome. Therefore, the rings were inserted before phacoemulsification began.

In our study, no case of intraoperative zonular dialysis occurred in eyes with a CTR. In the control group without a ring, however, complications resulting from zonular separation occurred in 12.8% of eyes. The absence of zonular dialysis in the CTR group is evidence that the ring is effective in preventing zonular separation during phacoemulsification in eyes with pseudoexfoliation syndrome. We believe that the different rates of intraoperative zonular complications between the 2 groups were not surgeon-dependent because the rates of the 2 surgeons in the study were not statistically different.

Capsular tension rings can also be used to help prevent intraoperative posterior capsule rupture by keeping the posterior capsule taut, preventing its anterior bulging and protecting it from being aspirated by phaco or irrigation/aspiration tips during phacoemulsification and cortical aspiration.[31] In our study, the rate of posterior capsule rupture was not statistically different be-

tween the CTR and control groups. Thus, we could not prove that the ring protects the posterior capsule.

Most eyes (94.9%) in our CTR group had a foldable IOL implanted in the capsular bag; in-the-bag fixation was possible in only 79.5% in the control group. This indicates that by decreasing the rate of intraoperative zonular separation, the CTR increases the rate of primary in-the-bag IOL implantation, preventing the complications of implantation of a different type IOL at a different site and of secondary procedures.

Complication rates between 1% and 25% have been reported for cataract surgery in eyes with pseudoexfoliation syndrome.[1–17] The rates reported after ECCE are commonly higher than those after phacoemulsification.[11,12] Other risk factors are the presence of preoperative phakodonesis, pupil miosis, and a shallow anterior chamber.[9,11,12,16,17] Our study included many eyes presenting with several risk factors. Approximately one half of the eyes had cataract with a hard nucleus (grade 3 and 4), one sixth had preoperative iridodonesis, two fifths had a miotic pupil, one third had coexisting glaucoma, and one half had an ACD of 2.5 mm or less. The vitreous loss rate was 5.1% and 20.5% in the CTR and control groups, respectively, with a statistically significant difference between groups. The complication rate in the CTR group was comparable to rates reported in the literature[11–16]; however, the rate in the control group was higher. We believe that the relatively high intraoperative complication rate in both groups was the result of the high incidence of preoperative risk factors in our cohort.

On the first postoperative day, approximately one third of the eyes in both groups had corneal edema that reduced BCVA. The insertion of a CTR did not influence the incidence of corneal edema. Although specular microscopy was not performed, we believe that the reduced endothelial cell counts and prolonged effective phacoemulsification times required for hard nuclei were responsible for the edema.

In our study, a fibrin reaction in the anterior chamber was seen in 17.9% and 7.7% of eyes in the control and CTR groups, respectively. Approximately half the eyes in both groups had miotic pupils that required mechanical dilation. The difference between the 2 groups was not statistically significant because that complication was thought to be a direct consequence of the preoperative BAB breakdown and pupil-expanding manipulations.[19,21–24]

In the early postoperative period, BCVA was not statistically different between the 2 groups. However, UCVA was better in eyes with a CTR. This shows that the prophylactic insertion of a CTR influenced UCVA but not BCVA. We believe the discrepancy occurred because a lower percentage of eyes in the control group had in-the-bag IOL fixation. The exact position of the IOL could not be accurately predicted, and errors in IOL power selection were made in some of these cases. Three eyes in the control group could not be implanted with an IOL in the first operation because of intraoperative complications. One was left aphakic, and 2 had secondary scleral fixation.

Multivariate regression analysis showed that the single significant predictor of early postoperative BCVA was patient age. Although correlated with BCVA in the univariate analysis, the presence of intraoperative zonular dialysis, vitreous loss, postoperative fibrin, and corneal edema were not statistically significant predictors of postoperative BCVA in the multivariate regression analysis. In elderly patients, the pathological alterations of pseudoexfoliation syndrome generally proceed to a relatively advanced stage. When patient age was excluded from the multivariate analysis, ACD became the principal determinant of BCVA. In a recent study, an inverse correlation between the incidence of intraoperative complications and ACD was observed in eyes with pseudoexfoliation syndrome.[16] The authors report that the risk was considerably higher when the ACD was less than 2.5 mm.[16] In our study, the ACD was 2.5 mm or less in 48.7% in the CTR group and 41.1% in the control group.

At the postoperative first visit at 24 hours, transient IOP spikes were observed in more control eyes than in eyes with a CTR. At the last visit, however, mean IOP was not significantly different between the 2 groups, both of which had statistically significant drops in IOP. The decrease in IOP after uneventful cataract surgery has been reported in many studies, and it is more commonly observed in eyes with occluded or closed angles and in patients with a shallow anterior chamber.[33–35] Many eyes in our study had a shallow anterior chamber preoperatively. We believe that the IOP reduction despite relatively high intraoperative complication rates in our study was a result of the deepening of the anterior

chamber and widening of the filtration angle achieved by the phacoemulsification surgery.

We implanted the CTRs just after the hydrodissection but before phacoemulsification. No attempt was made to rotate the nucleus before inserting the ring. Rotational and anterior–posterior forces that stretch the weakened zonules are created during nucleus manipulation (grooving, rotation). Therefore, the CTR should be inserted before this stage. Although the ring helps stabilize the capsular bag and helps the surgeon during nucleus manipulations, as shown in our current study, it might create difficulties for the surgeon during cortex aspiration, especially if the cortex is not totally cleaved from the capsule. Thus, we believe that cortical cleaving hydrodissection as described by Fine[36] should be performed in those cases and that the ring should be inserted just beneath the lens capsule, not between the superficial cortical fibers. In addition to meticulous cortical cleaving hydrodissection, a viscoelastic injection along the path of the ring may help separate the lens capsule from the cortex.

Our study had limitations. First was the small number in each group, which may have caused us to miss small but statistically significant differences between the 2 groups. Second, it would have been better had 1 surgeon performed all operations to prevent differences caused by surgical experience. We tried to overcome this by having each of the 2 surgeons operate on the same number of eyes. Third, the mean follow-up was short; thus, we could only assess the influence of the CTR intraoperatively and in the early postoperative period. Several studies report high rates of posterior capsule opacification (PCO) and anterior capsule contraction resulting in late IOL dislocation in eyes with pseudoexfoliation syndrome.[37–39] Capsular tension rings are reported to be effective in reducing these late complications in eyes with the syndrome.[32,40] A minimum of 1 to 2 years of follow-up will be needed to confirm that CTR implantation reduces the rates of IOL decentration and PCO. We are currently evaluating the late postoperative course of patients in both our study groups.

In conclusion, in this prospective randomized study, CTR implantation after capsulorhexis and hydrodissection but before nucleus emulsification reduced intraoperative complications caused by zonular separation, increased the rate of in-the-bag IOL fixation, and improved UCVA.

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