Descemet Stripping Automated Endothelial Keratoplasty for Bullous Keratopathy After Anterior-Posterior Radial Keratotomy

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Dr. Tsutomu Sato developed posterior keratectomy for the treatment of keratoconus in 1939. This technique was also used to correct astigmatism and myopia.[1] However, the results of anterior or posterior corneal incision for astigmatism and myopia were not satisfactory, so APRK was devised in 1943.[2] By 1959, Sato had abandoned this procedure because the development of contact lenses rendered such surgery unnecessary. Since then, the incidence of postoperative bullous keratopathy has increased progressively with each passing year, and it has been recognized that APRK is associated with a risk of corneal endothelial failure.[3] Posterior corneal incision was considered to be the cause of such problems, so thereafter RK was performed with anterior corneal incision alone and became increasingly popular.

Currently, Descemet-stripping automated endothelial keratoplasty (DSAEK) is the most popular procedure for bullous keratopathy, since it avoids all manual lamellar dissection and has the potential to achieve a smoother interface. It has been reported that a smoother interface may shorten the recovery time and improve the visual outcome.[4] After APRK, the posterior corneal surface gradually becomes irregular as thickened Descemet's membrane protrudes from the posterior surface of the cornea in the region of the incision near the corneoscleral limbus.[5,6] Therefore, it could be expected that DSAEK may not be an appropriate treatment for APRK patients. Accordingly, this case series examined the early outcome of DSAEK in patients who had received APRK. To the best of our knowledge, this is the first report about DSAEK in such patients.

PATIENTS AND METHODS

We retrospectively reviewed the records of every APRK patient in whom DSAEK had been performed by one experienced surgeon (S.N.) at Juntendo University Hospital between October 2008 and June 2012. The occurrence of graft detachment in the immediate postoperative period, the final BCVA, and the final ECD were recorded. Postoperative adhesion between the host cornea and the graft was examined by slit-lamp biomicroscopy and OCT. Table 1 summarizes the preoperative data of the 4 patients enrolled in this study. Approval was obtained from the Research Ethics Board of Juntendo University (Tokyo, Japan) and the patients gave written informed consent before each surgical procedure.

All donor tissues were prepared at the Juntendo Eye Bank using an artificial chamber and a Moria ALTK microkeratome (ALTK CBm; Moria) with a 300-μm head. Grafts were subsequently cut with a punch trephine (8- to 8.5-mm) during surgery.

After sub-Tenon injection of 1% lidocaine, DSAEK was performed through a 5.0-mm

temporal corneal incision. An anterior chamber cannula was inserted for paracentesis. In patients with cataract, simultaneous cataract surgery was performed using the phaco-chop technique. Descemet's membrane of the recipient was stripped from the posterior corneal stroma over a region corresponding to the dimensions of the graft. Inferior peripheral iridectomy was performed in all eyes to avoid postoperative pupillary block. The graft was inserted into the eye through the 5-mm corneal incision using a Busin glide (Asico, Westmont, IL, USA). Then the corneal incision was closed with 2–3 interrupted 10-0 nylon sutures and complete filling with air was maintained for 10 minutes. Fluid that accumulated between the recipient's stroma and the graft was drained via small incisions made in the midperipheral cornea of the recipient.

Patients were typically examined on postoperative day 1, after 1 week and 1 month, and monthly thereafter, unless circumstances indicated that more frequent follow-up was required. Patients received 0.1% betamethasone sodium phosphate eye drops 4 times daily for 3 months, followed by tapering thereafter at the discretion of the treating physician.

RESULTS

The indication for DSAEK was bullous keratopathy after APRK in all 4patients(Table 1). Representative slit lamp and OCT photographs obtained before and after DSAEK from Case 3 are shown in Figures 1 and 2. In all patients, stripping of Descemet's membrane was performed. At the same time, an attempt was made to remove any protrusions of Descemet's membrane, but it was difficult to do this adequately, because there were numerous protrusions and strong adhesions. There were no other intraoperative complications. Graft dislocation was noted in 3 cases. However, re-attachment could be achieved by a single rebubbling procedure and repeat DSAEK was not required. After surgery, localized corneal edema (presumably due to incomplete attachment) was noted at the periphery of the cornea in all patients except for Case 4. However, this resolved gradually and OCT revealed disappearance of any residual space between the host and graft tissues(Figure 3). In Case 4, APRK was performed twice, so this patient had more incisions that nearly reached the center of the cornea. Therefore, the postoperative space between the host and graft tissues was wider than in the other cases. However, the edema resolved by 9 months after surgery and visual acuity improved gradually (Table 2).

Before surgery, visual impairment due to severe corneal edema was common, because around 50 years or more had passed since APRK in all patients and it was a long time since the onset of BK in most of them. Visual acuity showed a significant improvement

at 1 month after surgery in all of the patients except for Case 4, who had band-shaped corneal degeneration. Acuity continued to improve gradually throughout the follow-up period in all cases (Table 2). Mean postoperative astigmatism was 1.50D±1.74D (range 0D-4.5D) ,almost patients could get useful vision.

Table 3 shows the changes of the endothelial cell density after surgery. Endothelial cell density was already reduced by at least 50% at the initial measurement after surgery in all patients apart from Case 1, who had fewer APRK incisions and underwent DSAEK alone. The cell density decreased gradually over time in all patients. In Case 4, the endothelial cell density could not be measured during follow up because of the presence of band-shaped corneal degeneration.

The graft size was decided without taking the old APRK incisions into consideration. It was decided with the host cornea size. Graft size is considered to have had no influence on graft dislocation, because it was 8.0 and 8.5 mm in the patients who did not need rebubbling(Table 2). In 3 patients(60%), graft dislocation occurred early after surgery and rebubbling was needed. However, donor-graft attachment could be achieved by a single rebubbling procedure in all of them, so repeat DSAEK was not required. After surgery, there was no intense fibrin reaction or rapid increase of intraocular pressure. There were no cases of graft failure.

DISCUSSION

In this small series, DSAEK was tried for patients who had an irregular posterior corneal surface after APRK. Although the rate of early graft detachment was high, re-attachment could be achieved by single rebubbling procedure in all cases and visual acuity was improved by DSAEK. Considering that the rebubbling rate was only 12% when DSAEK was performed for other diseases at our institution during the same period, the rebubbling rate after DSAEK following APRK was a very high 60%. The reason for postoperative graft dislocation is irregularity of the posterior corneal surface. Another reason is failure to maintain an adequate intraocular pressure after DSAEK. The incision used for insertion of the DSAEK graft is made at the site of APRK incision where the cornea is fragile, so it is difficult to maintain a sufficient intraocular pressure after surgery even if the incision is sutured. However, when rebubbling was performed a few days after surgery the wound was already covered by corneal epithelial cells and maintenance of an adequate intraocular pressure was easier, which presumably facilitated attachment of the graft after a single rebubbling in all cases.

Parenchymatous edema of the peripheral parts of the graft, (where attachment was poor) was noted early after surgery, but this gradually resolved with time (Figure 3).

The factors that promote graft attachment, such as corneal endothelial pump function, are considered to advance attachment gradually after surgery. However, if the factors inhibiting attachment are too strong, the process will advance slowly and if there is a large space between the host and graft tissues, attachment might not be achieved.

The present study showed that the postoperative decrease of ECD was greater than in other patients who underwent DSAEK at our institution. The rate of ECD decrease in the non-APRK patients treated at our institution during the corresponding period was 30% after one year. This was possibly ascribable to the influence of rebubbling, which was performed for postoperative graft dislocation, but the decline of ECD from baseline was similar in Case 3 who did not undergo rebubbling. In contrast, the decline of ECD was less marked up to 1 year after surgery in Case 1, who had fewer posterior corneal incisions for APRK and received DSAEK alone without simultaneous cataract surgery. These findings suggest that an irregular posterior corneal surface and performance of simultaneous cataract surgery can lead to an early decrease of ECD after surgery. The ECD continued to decrease gradually in all of our patients and the decrement of cell density exceeded 50% by 4 years after surgery even in Case 1.

The diameter of the corneal graft is an important consideration. Sites where protrusions exist on the posterior corneal surface can be confirmed by preoperative slit-lamp microscopy and anterior chamber OCT. If a graft is prepared to fit the smooth region without protrusions, the corneal diameter will become smaller than usual and the ECD of the whole graft will be quite low. However, if a graft with the usual diameter is prepared, gaps will occur at the sites of irregularity on the host's posterior corneal surface, resulting in the potential risk of inadequate graft attachment. In this study, standard grafts 8 to 8.5 mm in diameter were prepared and attachment was eventually achieved. However, the rebubbling rate and the postoperative rate of decline in the ECD were higher than usual, so it seems necessary to compare the outcome with that obtained by using grafts approximately 5 mm in diameter to avoid the irregular peripheral region. The results of such a comparison will be interesting.

The corneal transparency rate obtained with PK for APRK patients at our institution is 60% or less at 2 years after surgery and 50% or less at 5 years after surgery. In the present study, the mean follow-up period was 19 months and a clear corneal graft was maintained even in Case 4 with the complication of band-shaped corneal degeneration, so the corneal transparency rate at final follow-up was 100%. Because the postoperative loss of corneal endothelial cells was rapid, it is feared that corneal endothelial failure will recur in the future. However, in the event of recurrence, it would seem possible to perform DSAEK again. If repeat DSAEK proved to be impossible, penetrating

keratoplasty could be performed instead. Because most of patients with bullous keratopathy after APRK are elderly, handling of corneal sutures and use of hard contact lenses will often become more difficult in the future. Thus, it may be possible that DSAEK will be the procedure of first choice for corneal endothelial failure after APRK.

We conducted this study to evaluate the efficacy of DSAEK for treating bullous keratopathy after APRK. Although attention needs to be paid to the irregularity of the posterior corneal surface, inadequate graft attachment due to such irregularity was compensated to some extent by the factors promoting attachment. Because this study was conducted in a limited number of patients over a short period, it will be necessary to conduct further studies on a larger scale with longer follow up.

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Figure Legends

FIGURE 1.

(A)Representative Anterior segment photograph of the cornea in Case 3 with bullous keratopathy after APRK. The pattern of the incisions is typical for a patient who was treated for myopia.

(B)OCT photograph of the same eye. Thickened Descemet's membrane protrudes from the posterior surface of the cornea in the region of the incision (white arrow).

FIGURE 2.

(A) Anterior segment photograph of the same eye at 1 year after DSAEK.

(B) Anterior segment OCT image showing good graft attachment (white arrow) at the APRK incisions.

FIGURE 3.

Case 3: (A) Preoperative OCT reveals thickened Descemet's membrane protruding from the posterior surface of the cornea. (B) At 3 months postoperatively, OCT shows incomplete attachment of the graft. Protrusions of thickened Descemet's membrane have disturbed attachment (white arrow). (C) OCT at 6 months. (D) OCT at 1 year. There is progressive improvement of graft attachment.

Purpose: To report the outcome of Descemet-stripping automated endothelial keratoplasty (DSAEK) for bullous keratopathy after Sato's anterior-posterior radial keratotomy (APRK).

Methods: The clinical records of patients who had DSAEK surgery for bullous keratopathy after APRK were reviewed.

Results: Five eyes of 4 patients (4 men) were included. The mean age at DSAEK surgery was 81.8±7.1 years (range: 73–90 years) and the mean follow-up period after surgery was 19.8±16.9 months (range: 6–48 months). The mean preoperative logarithm of the minimum angle of resolution (logMAR)–corrected visual acuity was 1.96±0.50 (range: 1.2 to counting fingers), and this improved to 0.49±0.43 (range: 0.05 to 1.2) at final follow-up. The mean preoperative donor cornea central endothelial cell density (ECD) was 2826.0±335.7 cells/mm^2 (range: 2352 to 3150 cells/mm^2) and this declined to 863.5±501.7 cells/mm^2 (range: 500 to 1255 cells/mm^2) at final follow-up, a mean reduction of 68.2%. The mean graft size was 8.2±0.21 mm (range: 8.0－8.5 mm). Postoperative complications included early graft dislocation in 3 eyes (60.0%), with successful repositioning by a single rebubbling in all cases. There was no graft rejection and no patient required repeat DSAEK or PK for graft failure.

Conclusions: This small series suggests that DSAEK is an effective surgical option after APRK. Although there was a high rate of graft dislocation, this was successfully managed by rebubbling. Subsequently, the attachment of each graft improved gradually over time. DSAEK seems to be a reasonable alternative to penetrating keratoplasty for patients with bullous keratopathy after APRK.

Table1. Clinical Data Before Descemet-Stripping Automated Endothelial Keratopl

Case No.	Age (years	Gender	Eye	BCVA (logMAR before DSAEK	Manifest Refraction	Time From APRK to Surgery (years)
1	78	M	R	1.7	+5.00sphere	65
2	88	M	R	CF	Unable*	47
3	73	M	L	1.2	+3.00sphere	55
4	80	M	R	CF	Unable*	60
5	90	M	L	CF	Unable*	49
Mean	81.8			1.96		55.2

APRK,Anterior-Posterior Radial Keratotomy; BCVA,best-corrected visual acuity; C
DSAEK,Descemet-Stripping Automated Endothelial Keratoplasty; M,male; R,right; L
*Manifest refraction was unmeasurable due to severe bullous keratopathy.

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No. of posterior corneal incisions	Other Ocular Conditions
8	Cataract extraction posterior chamber lens
About	Corneal subepithelial opacity
About 45	
More than	Repeat APRK, Band keratopathy
About 45	

CF,counting fingers
„left

Table 2. Clinical Data After Descemet-Stripping Automated Endothelial Keratoplasty

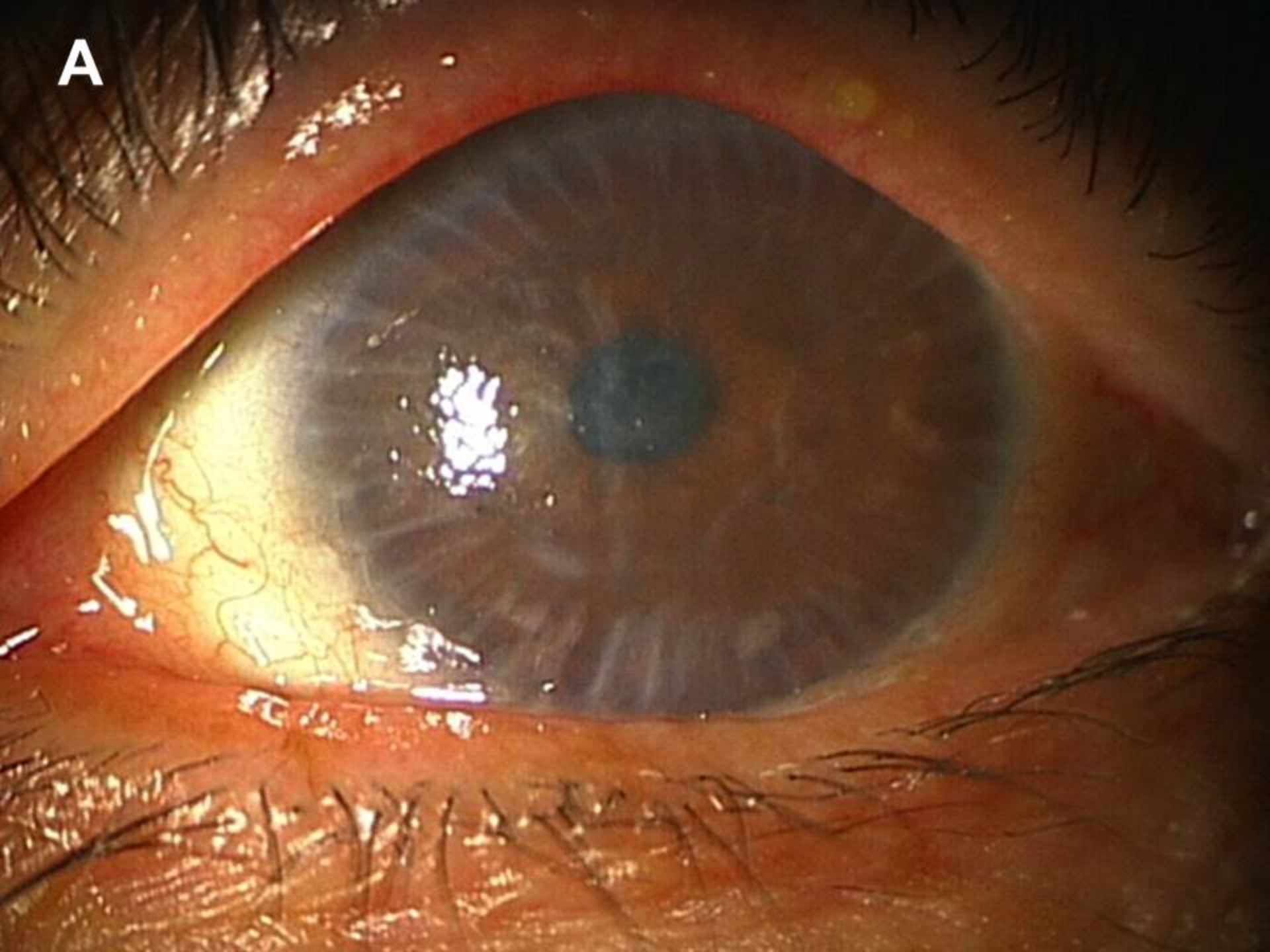
Case No.	Graft size (㎜)	Postoperative Complications	Additional Procedures	Postoperative BCVA(logMAR) 1 month	3 months	6 months	1 year	Final BCVA(logMAR	Manifest Refraction	Graft Status	Follow-Up Time (months)
1	8	None	None	0.22	0.22	0.22	0.22	0.05	cylinder −1.25 × 130	Clear	48
2	8.5	None	None	1.22	1.22	0.82	0.82	0.39	+2.75cylinder −4.5 × 13(	Clear	22
3	8.25	Graft dislocatior	Graft repositioned	0.52	0.52	0.52	0.22	0.3	+0.25cylinder −1.0 × 45	Clear	14
4	8	Graft dislocatior	Graft repositioned	1.52	1.52	1.4	—	1.22	+3.00sphere	Focal mild edema	9
5	8.25	Graft dislocatior	Graft repositioned	0.82	0.39	0.52	—	0.52	−3.50cylinder −0.75 × 5(	Clear	6
Mean	8.2			0.86	0.77	0.7	0.42	0.5			19.8

BCVA,best-corrected visual acuity; CF,counting fingers; D=diopters

Table 3. Endothelial Cell Density of the Donor Corneas

Case No.	Donor Corneal ECD	Postoperative 1 month	3 months	6 months	1 year	Final	Endothelial Cell Loss (%)
1	2650	2533	2415	2519	2398	1255	52.6
2	3150	848	999	652	640	600	80.1
3	2352	773	625	509	509	500	78.7
4	3125	N/A	N/A	N/A	—	N/A	—
5	2853	1272	910	1099	—	1099	61.5
Mean	2826	1356.5	1237.3	1194.8	1182.3	863.5	68.2

ECD,endothelial cell density (cells/㎟); N/A,not applicable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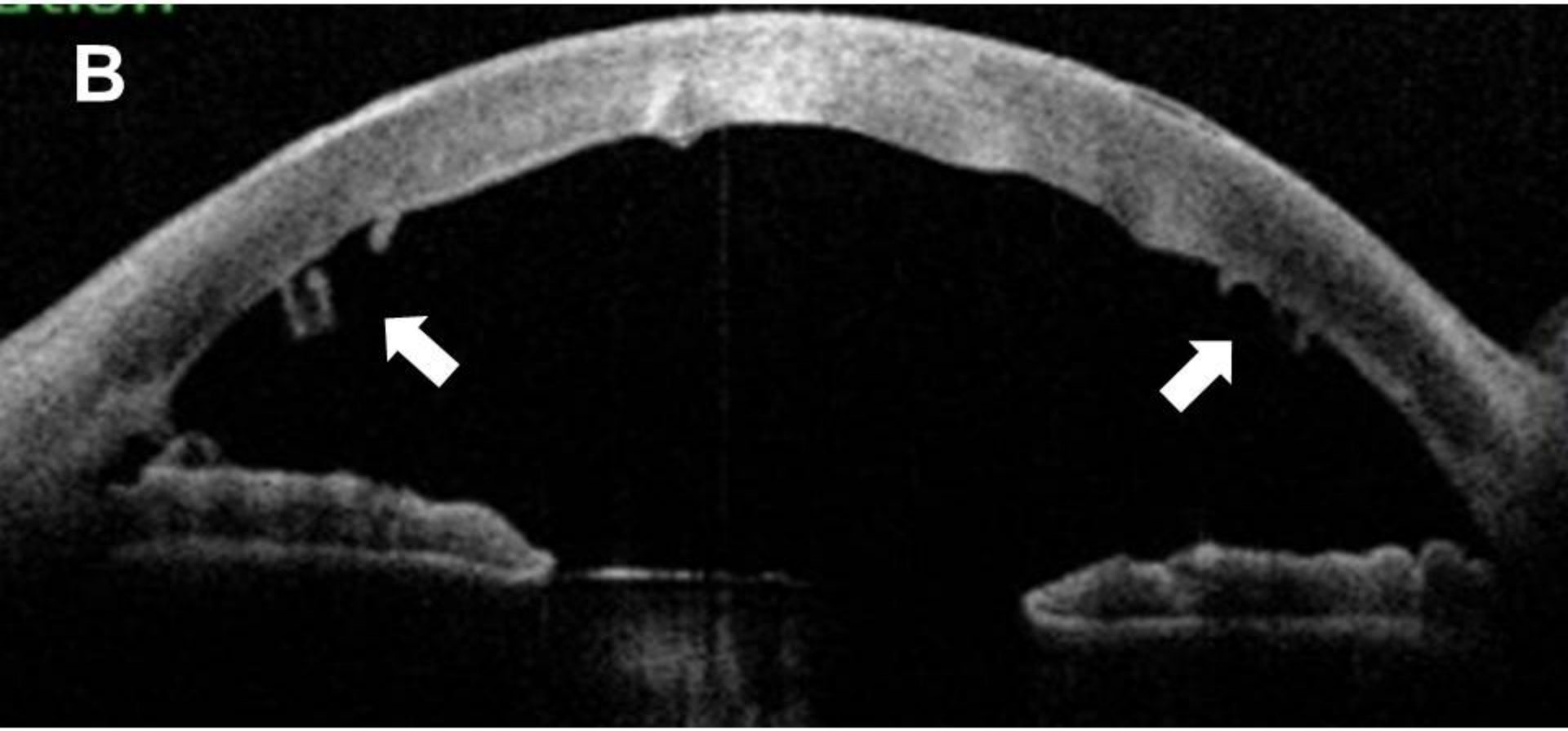
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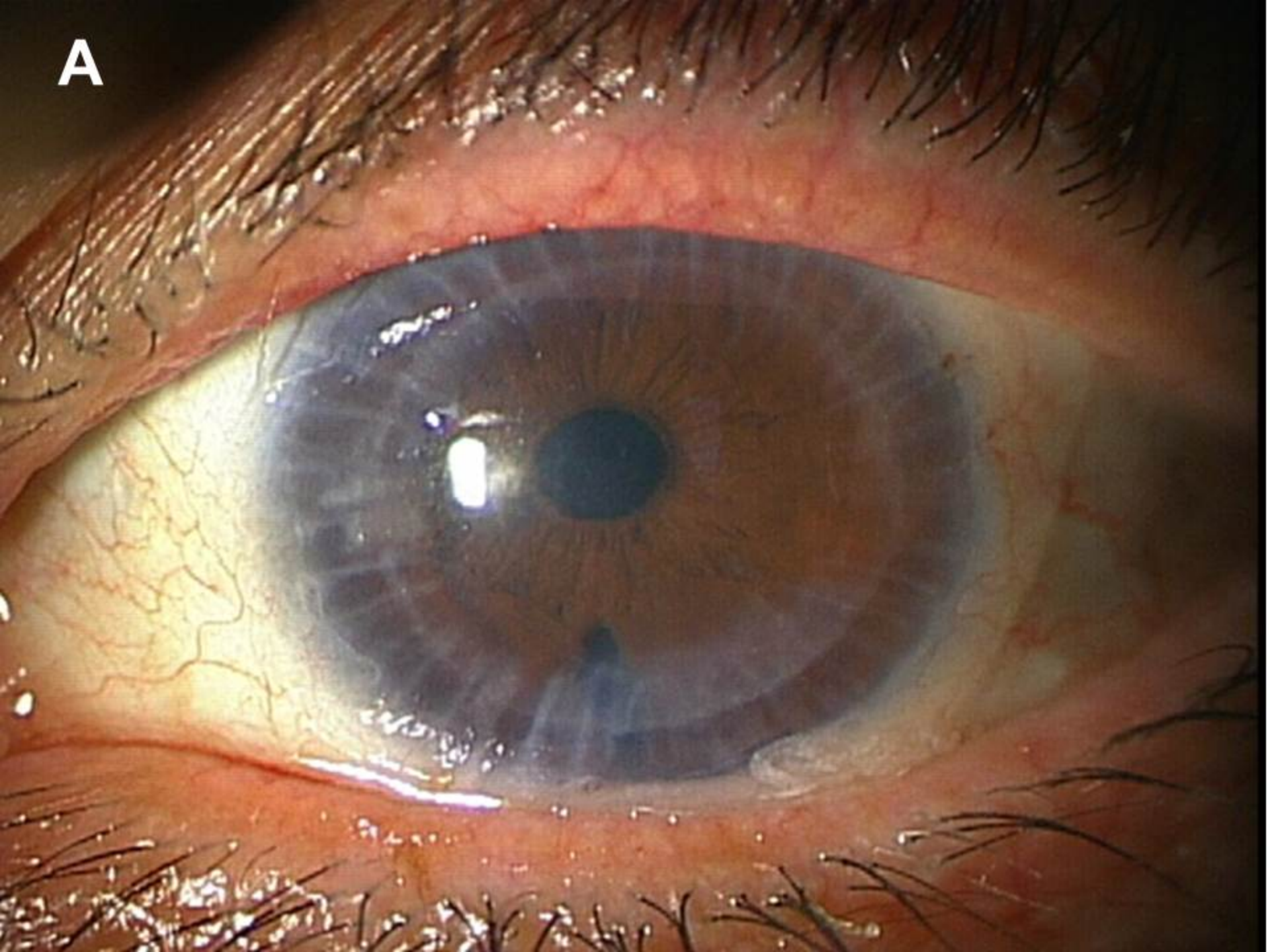
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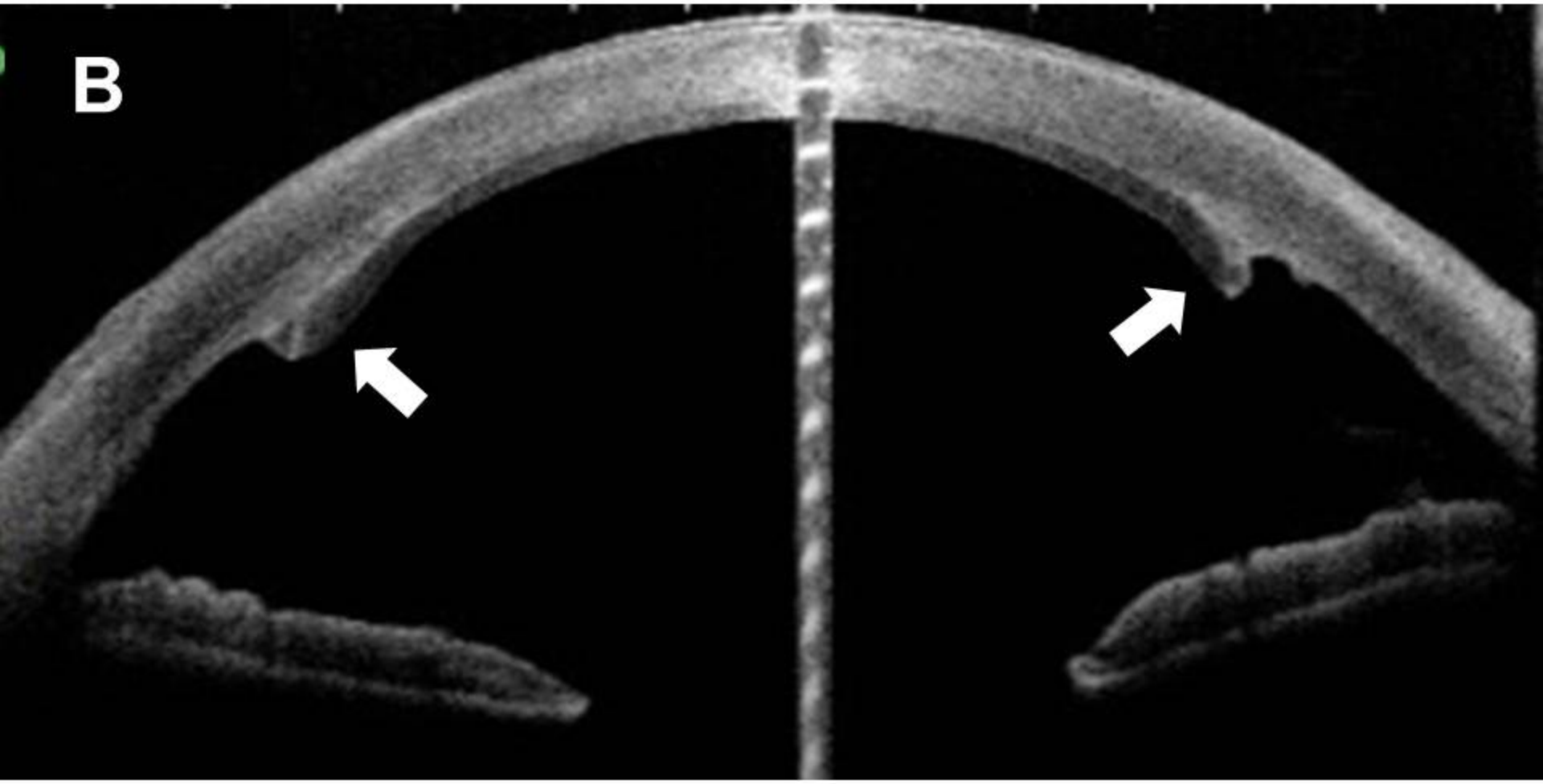
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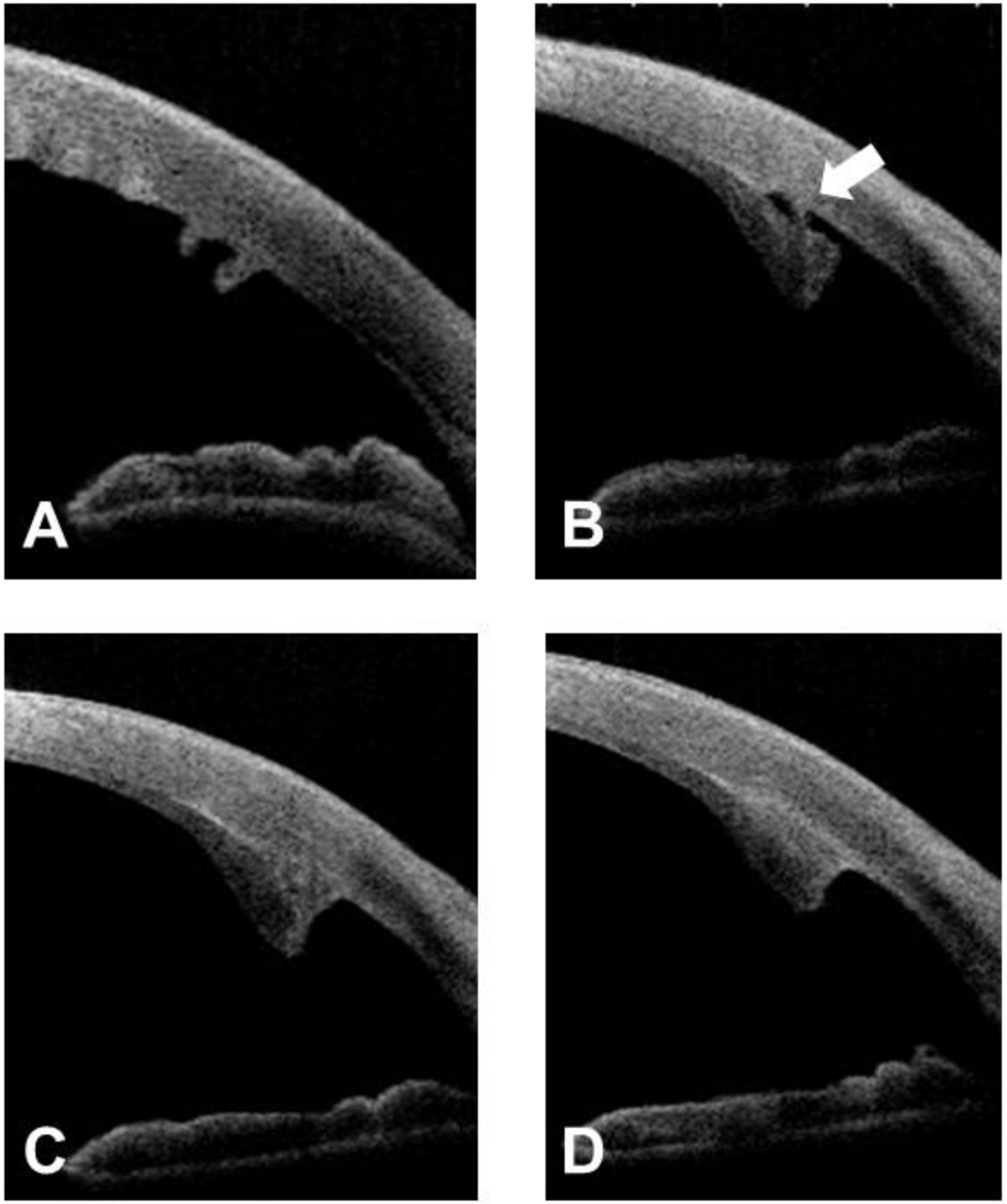
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