CLINICAL PRACTICE

Cataract Surgery in Pseudoexfoliation Syndrome

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Abstract. Many studies have shown that pseudoexfoliation syndrome patients have higher rates of intraoperative complications during and after cataract surgery compared to patients without the condition. This update reviews the etiology and appearance of pseudoexfoliation syndrome anterior segment changes and methods of managing complications. The ophthalmologist must be aware of the subtler signs of pseudoexfoliation syndrome prior to undertaking cataract surgery. Techniques for enlarging small pupils, overcoming zonular instability, modification of phacoemulsification technique, and appropriate choice of intraocular lens implant, could minimize the likelihood of intraoperative and postoperative complications. (**Comp Ophthalmol Update** 3: xx-xx, 2002)

Key words. cataract • phacoemulsification • pseudoexfoliation syndrome • zonular instability

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Pseudoexfoliation syndrome (PEX) is a common and clinically important systemic condition characterized by the pathological production and accumulation of an abnormal fibrillar extracellular material in many intraocular and extraocular tissues, the latter including muscles, heart, lungs, liver, kidney, and meninges.[1] A recent study found increased levels of latent and active transforming growth factor-beta1 in the aqueous humor of PEX patients, derived from enhanced local synthesis and activation, which promote the buildup of the abnormal extracellular elastic material characteristic of PEX.[2] Epidemiological studies have shown that the disorder exists with differing frequencies worldwide, with an increasing prevalence with age. We review the etiology and appearance of PEX anterior segment changes and methods of managing intraoperative and postoperative complications associated with PEX. The gold standard for the diagnosis of PEX is demonstration of PEX material on the anterior surface of the lens by electron microscopy. These morphologic alterations form the basis of clinical classification into the preclinical stage (clinically invisible), suspected PEX (precapsular layer),

mini-PEX (early ruboff of PEX material from the anterior lens capsule, typically in the superonasal quadrant), and classic PEX.[3]

PEX Phacopathy and Zonular Instability

Studies have shown that there is increased lens opacification with predominantly nuclear sclerotic cataracts in PEX syndrome.[4] The visible PEX changes in the pupillary area are important for diagnosis but relatively harmless. In the mini-PEX stage, focal defects may be seen in the superonasal quadrant of the precapsular layer caused by ruboff of PEX material. Zonular instability, which may lead to phakodenesis and lens subluxation, results from three different mechanisms. Initially, active production of PEX material by the pre-equatorial lens epithelium with proliferation through the capsular surface disrupts the zonular lamella and their insertion into the anterior lens capsule. Next, the zonules are separated from their firm origin and anchored in the basement membrane of the nonpigmented ciliary epithelium by locally produced, intercalating PEX fibers. Finally, PEX material contains proteolytic enzymes facilitating zonular disintegration.[2] Preoperative anterior chamber depth has been shown to be a major prognostic indicator for zonular weakness with complications during cataract surgery.[5]

PEX Iridopathy

All cell types may be involved in PEX production. The resulting PEX deposits and secondary ischemia cause iris rigidity leading to poor pupillary dilatation and also account for breakdown in blood aqueous barrier postsurgery.[6] Subtle signs of PEX iridopathy include loss of melanin from the peripupillary pigment epithelium of the iris, producing transillumination defects in the sphincter, anterior chamber melanin dispersion post mydriasis, melanin deposits on anterior segment structures, and insufficient mydriasis.

Trabecular Meshwork

An increase in intraocular pressure in PEX may be due to several mechanisms. The increased incidence of open-angle glaucoma in PEX patients compared to the normal population is caused by mechanical blockage of trabecular meshwork by PEX material with active PEX accumulation within trabecular cells causing secondary degeneration.[3] Trabecular blockage from melanin showers after mydriasis can cause an acute increase in intraocular pressure. Other mechanisms of glaucoma include angle closure from pupillary block[7] in the presence of broad posterior synechiae, and angle closure from spontaneous anterior subluxation of the lens causing ciliary block after miotics.[8]

PEX Keratopathy

Focal production of PEX exhausts corneal endothelial cells, causing secondary degeneration and corneal decompensation. This typically occurs as a bilateral, asymmetric, slowly progressive corneal endotheliopathy appearing in women in their sixties and older. The diffuse corneal edema in PEX keratopathy is different than that in Fuch's endothelial dystrophy, which usually starts centrally and spreads peripherally, and from bullous keratopathy, where the edema begins in the limbal region.[9] Further distinguishing characteristics include the absence of corneal guttata and the severe decrease in endothelial cell density demonstrated on endothelial cell microscopy (of up to 35% loss) in PEX keratopathy[10] with coincident glaucoma (Fuchs show a decrease of 16%[11]) compared to age-matched controls.

Surgical Challenges and Management

Scrolloli et al[14] have found that PEX patients were five times more likely to develop intraoperative complications during cataract surgery compared to patients without the condition.

SMALL PUPILS

Small pupils could be enlarged by prosthetic and nonprosthetic methods. Nonprosthetic techniques include viscomydriasis, manual iris stretching,[15] and iris microsphincterotomies.[16] Prosthetic techniques include iris hooks and the use of pupil expansion devices. Nonprosthetic techniques involve less instrumentation; however, the iris may be fairly atonic after manipulation and may interfere with the phacoemulsification

Focus Point #1

Signs suggestive of a diagnosis of pseudoexfoliation syndrome:

1. Pseudoexfoliation deposits on lens anterior capsule in pupillary area (classic pseudoexfoliation syndrome)
2. Phacoemulsification phacodenesis/lens subluxation
3. Intrastromal hemorrhage post mydriasis without rubeosis (indicative of iris vascular damage)
4. Pigment dispersion post mydriasis without obvious cause
5. Poor mydriasis and posterior synchiae without obvious cause[12]
6. Small anterior chamber depth[13] without other reasons for a narrow drainage angle
7. Pseudoexfoliation deposits on iris margin

process, whereas prosthetic devices generally provide more effective iris control. Flexible iris hooks could be used initially to enlarge the pupil[17] and then to stabilize the anterior capsule to prevent posterior subluxation of the lens.[18]

ZONULAR WEAKNESS

Traditional large-incision extracapsular surgery may be difficult due to the lack of zonular support to facilitate manual expression of the nucleus. Viscoexpression or manual vectis expression in these cases may be a safer alternative. Where there is >6 hours of zonular loss, the surgeon may need to revise the entire surgical approach and perform a vitreolensectomy or intracapsular lens extraction. Phacoemulsification causes less zonular stress than large incision extracapsular surgery but localized zonular weakness may require capsule stabilization. This may be achieved by using iris microhooks to stabilize the capsule[16] or implanting a capsular tension ring. An anterior chamber maintainer may be used to decrease anterior chamber bounce during phacoemulsification. If capsular stabilization is not used, an alternative method involves creating a large capsulorhexis, dislocating the nucleus anteriorly and performing the Kelman-type phacoemulsification in the anterior chamber. However, this is likely to lead to increased endothelial damage, given the greater proximity between the phacoemulsification tip and the corneal endothelium.

Capsular Tension Ring

A capsular tension ring allows for the expansion and stabilization of the capsular bag by redistributing forces with the resulting tautness of bag providing countertraction to facilitate phacoemulsification and cortical aspiration.[19] This is extremely useful for moderate degrees (i.e.,up to 5 hours) of zonular dialysis. The surgeon must first be capable of performing capsulorhexis on an unstable lens. The ring can be inserted after the completion of capsulorhexis but before hydrodissection,[20] creating a more stable environment for phacoemulsification. However, additional force is often required to remove remaining cortical material, which can become incarcerated between the ring and the capsular bag. Alternatively, the ring can be implanted after completion of phacoemulsification to facilitate the aspiration of cortex, as originally described by Cionni and Osher.[19] These authors have since introduced a new ring design with an eyelet for scleral fixation for use with greater degrees of zonular dialysis.[21]

CAPSULAR PROBLEMS

Problems may arise with initiation and completion of the capsulorhexis due to capsular fibrosis and fragility, and lack of zonular support. Better visualization can be achieved with capsular dyes. Strict attention should be paid to shearing forces on the capsule, and reduction of capsular tension, which may be achieved by many ways, including variation in head posture, utilizing high-viscosity viscoelastics, careful placement of eyelid speculum, and consideration to utilizing a two-stage capsulorhexis. We advocate a two-handed capsulorhexis technique where the second instrument is used to stabilize the tearing flap to avoid tangential traction on the capsule, which may cause remaining supporting zonules to unzip. A reasonably sized capsulorhexis (i.e., >5 mm) should be made to avoid postoperative lens decentration and fibrosis and all attempts must be made to enlarge an eccentric capsulorhexis.

HYDRODISSECTION AND HYDROLINEATION

In the presence of a fragile capsule and poor capsular support, meticulous attention should be given to achieve a gentle decompression of the bag capsular and to avoid the capsular blockage syndrome.[22] This occurs when a wave of hydrodissection is forced backward causing posterior capsular rupture. We also advise either hydro- or viscodelineation of the nucleus[23] so that all phacoemulsification and mechanical forces can be contained within the epinuclear space to minimize zonular stress.

PHACOEMULSIFCATION

One study has reported that head positioning can affect the anterior chamber depth.[13] A low-range bottle height should be available to decrease the depth of the anterior chamber, and flow rates should be kept low to avoid anterior chamber bounce and reduction of surge on the machine settings. Other methods to increase anterior chamber stability include the use of anterior chamber maintainers. We suggest that high cavitation tips should be used to minimize mechanical stress during sculpting and similarly, down sculpting should be avoided.[16] Chopping techniques are especially useful as the forces are expressed centripetally, avoiding zonular stress.[16] Two-handed rotations of the nucleus should be favored to ensure tangential forces, not vectorial forces, are generated and nonrotational cracking techniques have also been advocated. All maneuvers should occur in the capsular bag or in the pupillary plane to minimize the degree of endothelial damage. The surgeon may notice a particularly floppy capsule without overt zonular damage. We recommend that a capsular tension ring is inserted in these cases to stabilize the capsular bag and reduce the risk of inadvertent damage during intraocular lens (IOL) insertion. The surgeon should stabilize the capsular bag with viscoelastic prior to withdrawing the phacoemulsification probe in order

to minimize zonular stress. Aspiration of cortical material may be delayed until after IOL implantation, especially in cases in which a capsular tension ring has not been used, as the implant stabilizes the capsular bag.[16]

CHOICE OF INTRAOCULAR LENS IMPLANT

Posterior capsular opacification (PCO) can be reduced by four-quadrant hydrodissection, good sizing of the capsulorhexis, excellent cortical cleanup, and cleaning of anterior capsule.[24,25] Studies have shown that IOL material and design have marked effects on the rate of PCO[26] and anterior capsular opacification (ACO),[27] as well the long-term IOL centration.[28] The IOL of choice may be the foldable three-piece acrylic optic polymethyl methacrylate haptic IOLs.[29,30] Some surgeons prefer foldable silicone optic IOLs with polyamide haptics because of their ability to stabilize the capsule and resist the forces of fibrosis postoperatively. The plate haptic foldable silicone IOLs should be avoided. The IOL should be placed into the capsular bag, as this decreases the likelihood of fixation-induced decentration.[31] The surgeon could evaluate lens implant stability by the bounce test, which consists of deliberate decentration and release.[32] If this fails to result in spontaneous recentration the implant should be repositioned and re-evaluated. An intracameral miotic could also be administered to evaluate centration.

Focus Point #2

Surgical tips

1. Enlarge small pupils
2. Stabilize the capsule
3. Adequate size capsulorhexis
4. Gentle hydrosection
5. Avoid downsculpting and favor chopping the nucleus
6. Clean up cortical material
7. Choice of intraocular lens (acrylic optic, polymethyl methacrylate haptic, foldable)
8. Placement of intaocular lens into the capsular bag

POSTOPERATIVE INFLAMMATION AND IOP CONTROL

There is an increased breakdown of the blood aqueous barrier in PEX patients compared to normal eyes postcataract surgery and PEX eyes are more prone to postoperative inflammation.[33] Patients with PEX should be observed for signs of persistent postoperative inflammation and treated appropriately. There may be a role for increased frequency and duration of postoperative steroid treatment and the use of stronger steroid formulations and anti-inflammatory drops.

MANAGEMENT OF LATE COMPLICATIONS

Posterior Capsular Changes

Secondary cataract PCO has been shown to be more frequent following cataract surgery in patients with PEX.[34] The best approach for PCO is prevention as previously discussed. Clinically significant PCO is treated with Nd:YAG capsulotomy.

Anterior Capsular Changes

Capsule Contraction Syndrome With or Without IOL Decentration

Davison[35] first described capsule contraction syndrome in cases in which there was an exaggerated reduction in anterior capsulectomy and capsular bag diameter after extracapsular cataract surgery involving the use of a continuous curvilinear capsulorhexis. An imbalance of forces caused by zonular weakness results in an inability to resist the relatively increased strength of the centrally directed contractile forces generated by capsular fibrosis. An autopsy study[36] and clinical study[37] showed a significant increase in decentration of the entire capsular bag in PEX eyes. Other studies have shown an overall tendency for PEX patients to develop early anterior capsule contraction syndrome, with one study finding a 25% reduction in mean anterior capsulorhexis area of the PEX group compared to 10% in controls by 1 year, regardless of the IOL haptic material.[38] Complete anterior capsular occlusion in a PEX patient has also been reported despite capsular ring implantation.[39] We recommend the following preventative measures: create an optimal round anterior rhexis (just within the optic of the IOL) or a secondary capsulorhexis to enlarge the initial rhexis after completion of phacoemulsification. Performing intraoperative vacuuming of the undersurface of the anterior capsule prior to lens implantation has been shown to reduce the amount of residual lens epithelial cells[40] and reduce capsular fibrosis. Recent publications have shown that the choice of haptic and optic material influences the likelihood of anterior capsular contraction (the rigid PMMA haptics are more resistant to contractile forces than soft polypropylene haptics).[27-31] It has been suggested that patients with PEX and a small anterior capsulotomy opening should be scheduled for postoperative Nd:YAG laser capsulorhexis augmentation in the first few months following cataract surgery.[41]

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