

# Evaluation of anterior segment parameter changes after uneventful phacoemulsification in pseudoexfoliation syndrome

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## 假性剥脱综合征患者白内障超声乳化术后眼前节参数变化的评估

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### 摘要

**目的:**运用 Pentacam Schiempflug 成像系统研究假性剥脱综合征(PES)患者白内障超声乳化术后眼前节形态变化。

**方法:**前瞻性研究。共收集 31 例(42 眼)白内障合并 PES 患者接受白内障摘除术,选 27 例(42 眼)无 PES 的白内障患者作为对照组。Pentacam 检测术前和术后 1~3mo 的眼内压(IOP),前房深度(ACD),前房容量(ACV),前房角宽度(ACA)和瞳孔直径(PD)。t 检验检测术前和术后的变量。

**结果:**PES 组术前平均 IOP 明显高于对照组( $P=0.017$ )。两组在术前和术后的 ACD,ACV,ACA,IOP 值差异在 1~3mo 均有统计学意义( $P<0.05$ )。两组相比,PES 组的 IOP 下降更为显著;两组 ACD,ACV 和 ACA 的增量相似。PES 组术前 PD 值明显高于术后( $P<0.05$ )。两组 IOP,ACD,ACV,ACA 和 PD 的变化在术后 3mo 均趋于稳定。

**结论:**白内障超声乳化术均可显著降低患眼的 IOP,增加 ACD,ACV 和 ACA 的值,无论患眼是否患有 PES。ACD,ACV,ACA,PD 和 IOP 的变化在术后 3mo 趋于稳定。尽管 PES 组 IOP 下降更为明显,但无论白内障眼是否患有 PES,术后均表现出相似的眼前节特征。PES 患者早期接受白内障摘除术不仅能加深前房,且可使 IOP 稳定在正常范围。

**关键词:**假性剥脱;Pentacam;眼前节;白内障超声乳化术

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### Abstract

• **AIM:** To investigate the changes in anterior segment morphology using the Pentacam Schiempflug imaging system after uneventful phacoemulsification in pseudoexfoliation syndrome(PES).

• **METHODS:** We enrolled 42 cataractous eyes of 31 PES patients undergoing cataract extraction in this prospective study, 42 cataractous eyes of 27 patients without pseudoexfoliation comprised a control group. Intraocular pressure(IOP), anterior chamber depth (ACD), anterior chamber volume (ACV), anterior chamber angle width (ACA) and pupil diameter (PD) measurements were obtained preoperatively, and at 1 and 3mo postoperatively with the Pentacam. For the variables between the pre- and post operative periods; *t*-test was used.

• **RESULTS:** In PES group, the mean preoperative IOP level was significantly higher than the control group ( $P=0.017$ ). In both groups, the differences in ACD, ACV, ACA and IOP values measured preoperatively and postoperatively at 1, and 3mo were statistically significant ( $P<0.05$ ). When two groups were compared with each other, while reduction in IOP levels were more dramatic in PES group; increase in ACD,ACV and ACA were similar in both groups. Preoperative PD measurements were statistically higher than postoperative values ( $P<0.05$ ) in PES group. Changes in IOP, ACD, ACV, ACA and PD were stabilized at 3mo postoperatively in both groups.

• **CONCLUSION:** Uneventful phacoemulsification significantly reduces IOP, increases ACD,ACV and ACA in eyes with and without PES. Changes in ACD, ACV, ACA, PD and IOP remain stable at 3mo postoperatively. Although IOP reduction is more evident in PES group, cataractous eyes with and without PES exhibits similar anterior segment features after surgery. An early cataract extraction in pseudoexfoliation not only provides a wide and deep anterior chamber, but also leads to a stable IOP control similar to eyes without PES.

• **KEYWORDS:** pseudoexfoliation; Pentacam; anterior segment; phacoemulsification

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## INTRODUCTION

Pseudoexfoliation syndrome (PES) is the most important cause of secondary open angle glaucoma<sup>[1]</sup>. Presence of pseudoexfoliative material in anterior segment is strongly related to intraocular complications such as poor pupillary dilatation, phacodonesis, zonular instability, zonular rupture and corneal endothelial decompensation<sup>[2-4]</sup>.

PES and cataract frequently coexists and it's a known fact that PES increases the risk of complications during cataract surgery<sup>[2,4-5]</sup>.

Assessment of anterior segment parameters, such as anterior chamber depth (ACD), pupil diameter (PD) and anterior chamber angle (ACA) width, are important parts of the ophthalmic examination in patients with PES. While narrow ACD and ACA significantly increase the risk of complications following phacoemulsification surgery; a small undilating pupil leads surgeon to use of different surgical instruments that increase intraocular inflammation<sup>[4,6-7]</sup>.

Both imaging of the anterior segment with slit-lamp biomicroscopy and traditional evaluation of ACA by gonioscopy depends on subjective assessment. Different devices such as anterior segment optic coherence tomography, ultrasonic biomicroscopy, scanning peripheral ACD analyzer and Scheimpflug topography system have been used to assess anterior segment<sup>[8-12]</sup>.

The Pentacam (Oculus Inc., Wetzlar, Germany), with a rotating Scheimpflug camera, captures images of the anterior segment of the eye. It is a fast, non-invasive, reproducible and quantitative method to examine eyes that underwent phacoemulsification<sup>[12-13]</sup>.

In this prospective study, we aimed to investigate the effect of uneventful phacoemulsification on ACD, anterior chamber volume (ACV), ACA, pupil diameter (PD) and intraocular pressure (IOP) in pseudoexfoliative eyes during 3mo postoperative period. Secondary purpose of this study was to compare these changes to eyes without pseudoexfoliation.

## SUBJECTS AND METHODS

A total of 42 cataractous eyes of 31 consecutive patients with PES that underwent uneventful phacoemulsification were enrolled in this prospective study. A control group of 42 cataractous eyes of 27 patients without PES was employed for comparison. Patients with any type of glaucoma, history of previous ocular surgery, co-existing ocular disease and any intraoperative complication were excluded. PES patients receiving IOP lowering medications were also not included as drugs might affect IOP levels postoperatively. The study protocol adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from each patient prior to any procedure.

Before surgery, all subjects underwent a comprehensive ocular examination, including visual acuity assessment using the Snellen chart, slit-lamp examination, Goldmann applanation tonometry, gonioscopy, optic disc examination and measurement of central corneal thickness.

PES syndrome was identified when presence of PES material

was noted on lens capsule, iris, or corneal endothelium with repeated in-office IOP measurements <21 mmHg, no clinical evidence of glaucomatous optic neuropathy and absence of any perimetric defect. Static perimetry (Humphrey) was performed by pseudoexfoliative patients only. Control subjects were individuals without evidence of exfoliation deposits on anterior segment structures, who had repeated IOP readings of <21 mmHg and normal-appearing optic discs (cup/disc ratio smaller than 0.3 and absence of any neuroretinal rim defect or hemorrhage). In both groups patients had gonioscopically open angles and (LOCS II and III) cataracts which reduced visual acuity.

Pentacam measurements were performed in a dark room under standard dim illumination without pupil dilation. This system uses a rotating Scheimpflug camera and a monochromatic slit-light source that together rotate 360° around the optical axis of the eye. The system acquires 25 images of the anterior segment of the eye. This imaging provides measurements of ACD, ACV, ACA width and PD.

The ACD measurements obtained by the Pentacam do not include corneal thickness and are measured from the endothelium to the anterior crystalline or IOL surface. For the ACA width assessment; temporal, nasal, superior and inferior measurements were recorded. However, in this study, the narrowest quadrant (superior) was taken into account.

All surgeries were performed by one surgeon (Kemer OE) under topical or subtenon anesthesia, using a clear corneal incision. A capsulorhexis size of 5, 5-6 mm was ensured. Intracameral adrenalin (0.0001%) was used for pupil dilation when needed. Iris retractors or any stretching technique were not used in patients. Following hydrodissection, the nucleus was emulsified using the stop and chop technique, cortical cleanup was performed, and a one-piece foldable hydrophobic acrylic IOL (EYECRYL PLUSÔ) was inserted. The incision was closed with stromal hydration.

Postoperatively, patients were prescribed topical antibiotics four times daily for a week and steroids six times daily for 2wk. Topical steroids tapered during one-month period. At postoperative 1<sup>st</sup> and 3<sup>rd</sup> month, all measurements were repeated and recorded.

Statistical analysis was performed with Eviews. Numerical variants were reported as means ± standard deviations (SD). For the variables that showed normal distribution between the pre- and post-operative periods; t-test was used. For the variables that did not show normal distribution; Wilcoxon Sign test was used. A value of  $P < 0.05$  was considered statistically significant.

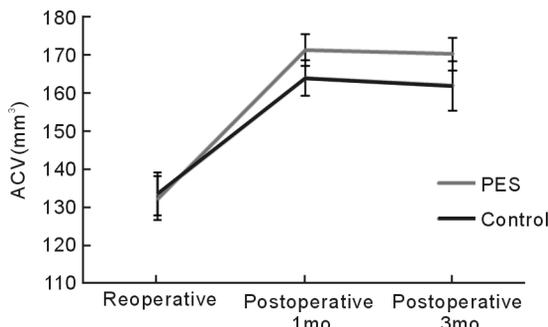
## RESULTS

The mean age of the patients were 72.1 ± 8.3 and 66.6 ± 9.6y in PES (Group 1) and control group (Group 2) respectively. Table 1 shows the mean ACD, ACV, ACA, PD and IOP measurements taken by the Pentacam in both groups preoperatively and at postoperative month 1 and 3. Despite both groups have similar preoperative ACV (Figure 1), ACD

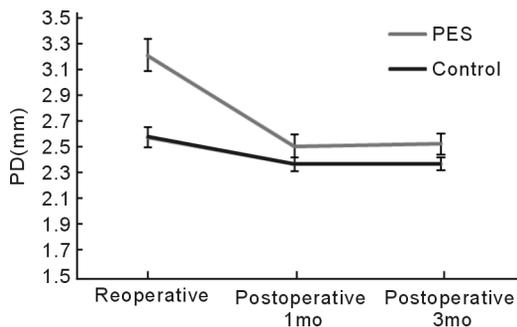
**Table 1 Pre- and postoperative anterior segment parameters**

Group	IOP(mmHg)	ACV(mm <sup>3</sup> )	ACD(mm)	ACA(degree)	PD(mm)
PES group					
Preoperative	17.50±3.11 <sup>b</sup>	132.31±37.10 <sup>b</sup>	2.60±0.39 <sup>b</sup>	31.10±5.53 <sup>b</sup>	3.21±0.80 <sup>b</sup>
Postoperative 1mo	14.21±3.30	171.29±26.93	3.85±0.71	44.93±4.90	2.52±0.56
Postoperative 3mo	14.00±2.47	170.24±27.34	3.80±0.68	45.03±5.27	2.53±0.52
Control group					
Preoperative	15.74±3.54 <sup>b</sup>	133.40±36.33 <sup>b</sup>	2.65±0.56 <sup>b</sup>	33.61±7.00 <sup>b</sup>	2.58±0.50
Postoperative 1mo	13.88±2.69	164.00±30.58	3.56±0.75	42.89±6.60	2.38±0.34
Postoperative 3mo	13.48±2.53	161.90±42.17	3.55±0.92	43.66±5.54	2.38±0.34

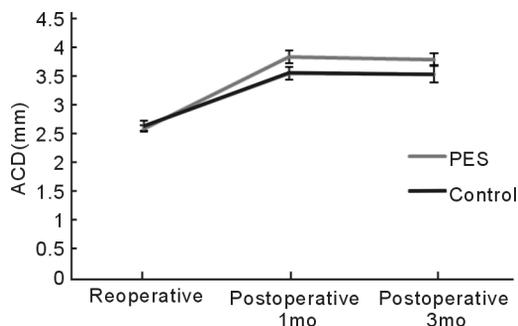
IOP: Intraocular pressure ; ACV: Anterior chamber volume; ACD: Anterior chamber depth; ACA: Anterior chamber angle; PD: Pupil diameter; <sup>b</sup>Difference between observation times is statistically significant ( $P<0.05$ );



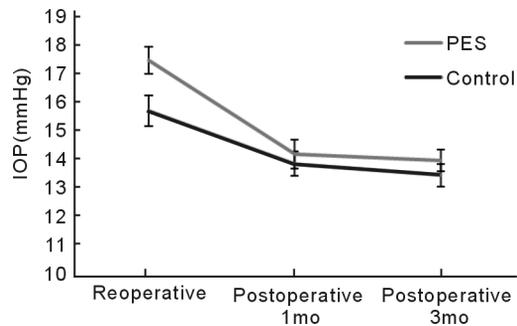
**Figure 1 Preoperative and 1-, 3-month postoperative measurements of ACV.**



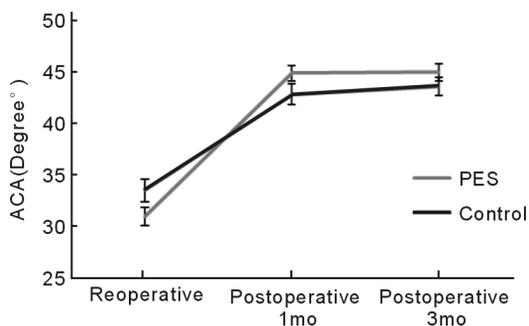
**Figure 4 Preoperative and 1-, 3-month postoperative measurements of PD.**



**Figure 2 Preoperative and 1-, 3-month postoperative measurements of ACD.**



**Figure 5 Preoperative and 1-, 3-month postoperative measurements of IOP.**



**Figure 3 Preoperative and 1-, 3-month postoperative measurements of ACA.**

(Figure 2), ACA (Figure 3) and PD (Figure 4) values; In PES group, the mean preoperative IOP levels (Figure 5) were significantly higher than the control group ( $P=0.017$ ). The reduction of IOP in PES group was more significant than control group ( $P<0.05$ ). Compared to the preoperative measurements, the mean postoperative ACV, ACD and ACA values were significantly higher whereas IOP levels were

lower (Figures 1, 2, 3, 5) ( $P<0.05$ ). However, when two groups were compared with each other, changes in these parameters were similar and not statistically significant ( $P>0.05$ ). While in group 1, preoperative PD measurements were statistically higher than postoperative values ( $P<0.05$ ); the difference between pre- and postoperative PD measurements were not statistically significant in group 2 ( $P>0.05$ ). Changes in IOP, ACD, ACV, ACA and PD were stabilized at 3mo postoperatively.

**DISCUSSION**

After phacoemulsification, a significant IOP fall is detected in eyes with pseudoexfoliation<sup>[14-17]</sup>. High fluid flow rates rapidly clean up the pseudoexfoliative material and this could result in reduction of IOP in short term<sup>[18]</sup>. Replacement of a thinner IOL, widening of ACA, increased aqueous humor outflow are thought to be connected to lower IOP levels in long term<sup>[20-21]</sup>.

In addition, by eliminating iridolenticular contact; dispersion

of the pseudoexfoliation material from iris decreases<sup>[22]</sup>. Kristianslund *et al*<sup>[15]</sup> claimed that the number of newly diagnosed glaucoma cases was lower than expected 6–7y following cataract extraction in the PEX group. In our study we found that compared to preoperative measurements, at 1mo postoperatively, the mean IOP levels were significantly lower ( $P < 0.05$ ). IOP values remained stable at 3mo postoperatively. IOP reduction was more evident in PES group than in control group. As we only included LOCS II and III cataracts to this study, we believe that the zonules were more integrated and a highly probable inflammation might have been prevented. By eliminating pseudoexfoliative material, we could say that patients with PES might benefit from an earlier cataract extraction to maintain an efficient IOP control.

While the ACD values obtained by ultrasound biometry include central corneal thickness; Scheimpflug technology takes the area between the corneal endothelium and anterior surface of the lens into account<sup>[23]</sup>. It could be claimed that the corneal topography measurements are more reliable than ultrasound biometry. In several studies it was claimed that Pentacam could not fully visualize the entire angle especially the most peripheral part of the iris and base of the angle and anterior segment OCT is superior in assessing ACA<sup>[24–25]</sup>. However, Grewal *et al*<sup>[26]</sup> suggested that ACV measurements using Pentacam can be used to screen narrow angles. Patients with ACD measurements smaller than 2.5 mm have 4 times higher intraocular complication risk than patients with normal ACD<sup>[6]</sup>. In many studies it is detected that after uneventful phacoemulsification, alterations in ACV and ACD values correlate with each other<sup>[27–29]</sup>. Using the Pentacam, Hayashi *et al*<sup>[21]</sup> reported significantly higher ACD and ACV levels in open angle glaucoma, angle closure glaucoma and normotensive patients after phacoemulsification.

Likewise, there are also several studies that state the changes in ACD and ACV in normotensive patients<sup>[27–31]</sup>. Moghimi *et al*<sup>[14]</sup> showed that non-glaucomatous patients with PES experience a dramatic rise in ACD. Similar to these reports, we found a dramatic rise in ACD and ACV values in PES after cataract surgery. As in Hayashi *et al*'s study<sup>[21]</sup> changes in ACD and ACV could be related to a backward shift of the iris after crystalline lens removal, and the relief of possible co-existing relative pupillary block, which is frequently seen in PES.

Increased lens thickness, advanced age and zonular instability contribute to a higher risk of developing angle closure in pseudoexfoliative patients. In several studies, it is shown that at 3mo postoperatively, ACA significantly widens in normotensive patients<sup>[27–28,30]</sup>; in primary angle closure glaucoma<sup>[29]</sup> and in non-glaucomatous patients with PES<sup>[14]</sup>. We found that in both groups, ACA widens significantly after phacoemulsification. We advocate that cataract extraction leads to a wider ACA width in PES and it could help us to prevent angle closure which is very likely to occur secondary to zonular laxity.

There are many studies suggesting that pupil size remains unchanged in normotensive patients after

phacoemulsification<sup>[27–28]</sup>. However, Kanellopoulos *et al*<sup>[31]</sup> suggested that 11% to 13% decrease in pupil size was detected after cataract surgery and it is strongly correlated to increase in ACV and ACD. As correlated with this study, we found that in group 1, postoperative PD measurements were statistically lower than preoperative values ( $P < 0.05$ ). Besides physiological myosis, this finding could be related to the limitation of pupil movements caused by pseudoexfoliation in both dim and bright illumination.

To our knowledge, this is the first report that compares the IOP and anterior segment parameter changes in pseudoexfoliation syndrome to a control group after phacoemulsification. In this study we observed that the reduction in IOP levels in PES is more dramatic and cataractous eyes with and without PES exhibits similar anterior segment features after surgery. Uneventful phacoemulsification with posterior chamber IOL implantation in PES and control subjects lead to significant changes such as lower IOP and greater ACD and ACV. We observed that 3mo postoperatively, IOP levels and anterior segment features were still stabilized. By replacing a thinner IOL and cleaning the pseudoexfoliative material, we could delay pseudoexfoliation syndrome turn into chronic pseudoexfoliation glaucoma and contribute to an early visual rehabilitation. Nevertheless, long term follow up studies in pseudophakic PES patients are needed to support our hypothesis.

We conclude that an early cataract extraction in pseudoexfoliation results in significant widening of ACA, ACD and ACV that leads to a stable IOP control similar to eyes without pseudoexfoliation. Earlier cataract extraction in these patients is important as it avoids high risks of complications due to advanced zonular laxity, harder cataracts and possible late IOL in-the-bag dislocation syndrome.

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