

Comparison of Phacoemulsification Parameters in Hard Nucleus with or without Pseudoexfoliation Syndrome

Psödoeksfoliasyon Sendromu Olan ve Olmayan Sert Nükleuslarda Fakoemülsifikasyon Parametrelerinin Karşılaştırılması

Aysegül KOÇAK ALTINTAŞ¹, Veysel CANKURTARAN², Kemal TEKİN³

ABSTRACT

Purpose: To compare the phacoemulsification parameters in hard nucleus with or without pseudoexfoliation (PEX) syndrome and to evaluate intraoperative preventive manipulations to avoid surgical complications.

Materials and Methods: 241 eyes of 241 patients were evaluated. 53 eyes of 53 patients were in PEX group and the remaining 188 eyes were in the control group (CG). All patients underwent surgery by longitudinal cold phaco, by the same surgeon with the same preoperative set-up parameters. The phaco parameters including effective phacoemulsification time (EFT), phacoemulsification percentage (PP), ultrasound time (UST), and surgical complications and preventive manipulations compared between groups.

Results: The mean UST was 80.41 second (sec) in PEX Group and it was 71.17 sec in the CG. UST was statistically significantly longer in PEX group than CG (p=0.03). The mean EFT was 28.55 sec in PEX group while it was 43.29 sec in CG. The EFT was statistically significantly shorter in PEX group than CG (p=0.008). The mean PP was 17.11% in PEX group while it was 17.82% in CG. The difference was not statistically significant (p=0.32). The requirement of both Capsule Tension Ring (CTR) and Iris Retractor Hook (IRH) implantations were significantly higher in PEX group than CG (p=0.001 for each one).

Conclusion: Uneventful phaco surgery in eyes with hard nucleus combined with PEX could be performed in longer period with shorter EFT and similar PP comparing to eyes without PEX. With the help of preventive approaches the overall outcomes for patients with PEX can be similar to those for non-PEX patients.

Key words: Effective phacoemulsification time, pseudoexfoliation syndrome, phacoemulsification percentage, ultrasound time.

ÖZ

Amaç: Psödoeksfoliasyon sendromu (PES) olan ve olmayan sert kataraklı gözlerdeki fakoemülsifikasyon parametrelerinin karşılaştırılması ve cerrahi komplikasyonların önlenmesi için yapılan girişimlerin incelenmesi amaçlandı.

Gereç ve Yöntem: Sert kataraktı olan 241 olgu incelendi. 53 olguda PES mevcutken (PES Grubu), kalan 188 olgu kontrol grubunu (KG) oluşturuyordu. Tüm olgular aynı cerrah tarafından cihaz ayarları aynı tutularak longitudinal soğuk fako yöntemiyle ameliyat edildi. PES grubunun ve kontrol grubunun Ultrason zamanı (UZ), efektif fako zamanı (EFZ), fako yüzdesinden (FY) oluşan fakoparametreleri cerrahi komplikasyonlar ve komplikasyonları önlemeye yönelik manüplasyonları karşılaştırıldı.

Bulgular: Ortalama UZ PES'li grupta 80.41 saniye (sn) KG'da ise 71.17 sn olarak tespit edildi. Ortalama UZ PES grubunda kontrol grubuna göre anlamlı oranda uzundu (p=0.03). Ortalama EFT PES'li grupta 28.55 sn iken, KG'da 43.29 sn idi. Ortalama EFT PES'li grupta anlamlı oranda kısaydı (p=0.008). Ortalama FY'leri PES'li grupta %17.11, KG'da ise %17.82 olup fark istatistiksel olarak anlamsızdı (p=0.32). Kapsül germe halkası ve iris retraktör kancalarının takılması ihtiyacı PES'li grupta anlamlı oranda fazlaydı. (p=0.001, her biri için).

Sonuç: Sert kataraktlı PES'li olgulardaki komplikasyonsuz fako cerrahisinin kontrol grubuna göre uzun bir zaman periyodunda, kısa efektif fako zamanı kullanılarak benzer fako yüzdeleriyle gerçekleştirildiği gözlemlendi. Komplikasyonları önlemeye yönelik uygulamalarla cerrahi başarı oranlarının her iki grupta benzer olduğu saptandı.

Anahtar Kelimeler: Efektif fakoemülsifikasyon zamanı, psödoeksfoliasyon sendromu, fakoemülsifikasyon yüzdesi, ultrason zamanı.

- 1- M.D. Associate Professor Ulucanlar Eye Training and Research Hospital, Eye Clinic, Ankara/TURKEY
ALTINTAS KOÇAK A., aysegulkaltintas@hotmail.com
- 2- M.D. Samandağı State Hospital, Eye Clinic, Hatay/TURKEY
CANKURTARAN V., dr.veyselcankurtaran@hotmail.com
- 3- M.D. Asistant Ulucanlar Eye Training and Research Hospital, Eye Clinic, Ankara/TURKEY
TEKİN K., kemal_htepe@hotmail.com

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Yazışma Adresi / Correspondence Address:
M.D. Associate Professor Aysegül KOÇAK ALTINTAS
Ulucanlar Eye Training and Research Hospital,
Eye Clinic, Ankara/TURKEY

Phone: +90 312 312 62 61
E-mail: aysegulkaltintas@hotmail.com

INTRODUCTION

Phacoemulsification is the main choice of most ophthalmologists in cataract surgery even eyes with hard nucleus. Eyes with pseudoexfoliation syndrome (PEX) is an abnormal fibrilopathy characterized by gradual synthesis, progressive accumulation and deposition of exfoliation material in the anterior segment of the eye such as corneal endothelium, anterior lens capsule, zonules and ciliary body.¹⁻⁴ Presence of PEX predispose for a broad spectrum serious surgical complications such as difficulty of pupillary dilatation and creation of capsulorhexis. In addition, PEX contributes to weakening of the suspensory apparatus of the crystalline lens that causes instability of anterior chamber, increased the risk of zonular dialysis, posterior capsule tear rupture, vitreous loss, and dropped nucleus or fragment. These complications are mainly believed to be increased by excessive surgical trauma.⁵⁻⁸

Surgical traumas by phacoemulsification parameters including amount of ultrasound energy, total phacoemulsification time, effective phacoemulsification time, phacoemulsification percentage may change according to risk factors such as history of ocular trauma or operation, congenital anomalies, hardness of nucleus and PEX.⁹⁻¹⁰

The aim of this study was also to compare the phacoemulsification parameters in hard nucleus with or without PEX and to evaluate intraoperative preventive manipulations to avoid surgical complications.

MATERIALS AND METHODS

241 eyes of 241 patients underwent phacoemulsification surgery with the cataract of nucleus density grade 4 were recruited for this study. Subjects were divided into two subgroups in which eyes with PEX (PEX Group) and the eyes without PEX and any other disease (Control Group). The current study was designed in accordance with the Declaration of Helsinki. After patients were informed about the nature of the surgery provided written consent was obtained.

All patients had undergone detailed preoperative examination included best corrected visual acuity (BCVA), tonometry, keratometry, detailed slit lamp examination, A-scan biometry and pachymetry. Patients having history of ocular surgery, ocular trauma, presence of corneal diseases that affect anterior segment visualization, uncontrolled glaucoma, zonular instability or pupil pathologies due to congenital anomalies such as marfan syndrome or ectopia lentis et pupilla were excluded.

A diagnosis of PEX syndrome was made by observing characteristic gray-white PEX material either on the surface of the anterior lens capsule or pupillary border of iris surface in both eyes. Nuclear hardness was classified clinically according to color of the nucleus and degree of fundus view from Grade 1 to Grade 5.¹¹ In this study only Grade 4 with yellow amber color nucleus and poor fundus reflex were included. Soft cataracts and eyes with Grade 5 which has dark brown or black color nucleus and absent of fundus view were excluded.

Each eyes were operated by the same experienced surgeon by the same phacoemulsification machine with divide and conquer mode and using with the same BSS and ophtalmic viscoelastic device. All subjects underwent phacoemulsification with local anaesthesia. Phacoemulsification was performed using with micropulse White Staar technology by Signature (Abbott Medical Optics, Santa Ana, CA, USA) as follows; creation of a main clear corneal and two side port incisions, injection of viscoelastic substance (VES) into the anterior chamber and a creation to continuous curvilinear capsulorhexis (CCC). After completion of a careful hydrodissection procedure, complete nuclear rotation was performed as free nucleus from the capsular connection to minimizes the stress on zonules during phacoemulsification. All patients underwent surgery by longitudinal cold phaco, with the same preoperative set-up parameters. In performing groove on time/off time of duty cycle was 8/4 msec. Nucleus was removed with divide and conquer technique, in this stage to increase cavitation energy (Increased Control and Efficiency) mode with kick power of 8 in initial 1 milisecond was activated. In phacofragmentation 6/6 msec on time/off time in each duty cycle was selected and CASE (Chamber Stabilization Environment) mode as an antisurge mechanism was used. Preoperatively US power set up selected in range of 30%-50% in all patients. After aspiration of the cortex and injection of VES, acrylic IOL inserted with the injector system into the capsular bag. VES was aspirated from the anterior chamber after which hydration was used to corneal wound closure. At the end of the surgery phacoemulsification parameters consist of effective phacoemulsification time (EFT), phacoemulsification percentage (PP) and ultrasound time (UST) were recorded.

All parameters were evaluated using statistical package for Social Science Version 15.0 (SPSS INC, Chicago IL). To compare the aged differences between pseudoexfoliation and control group Mann Whitney U was used. Mann Whitney U test was used to compare UST, EPT and PP in each group too. Nominal categorical variables analysis with Chi-square test and an overall p-value of less than 0.05 was considered to show a statistically significant result for each comparison.

RESULTS

In present study 241 patients of whom 53 eyes of 53 patients were in PEX group and 188 eyes of 188 patients were in control group recruited. The mean age of PEX Group was 71.47 years (range of 47 to 88); and of the control group the mean age was 65.56 years (range of 41 to 90). The PEX Group was significantly older than control group ($p=0.001$). Overall, 131 (54.3%) of the patients were male and 110 (45.6%) were female. Participant characteristics are displayed in Table 1.

No one had any intraoperative complications such as posterior capsule rupture, vitreous loss, and descemet's membrane detachment. Corneal edema did not persist more than a week in any patients. A total of 18 (7.46%) patients needed pupillary area enhancement with the help of iris retractor hook implantation, 16 (30.1%) of them were in PEX group while only 2 (1.06%) cases were in control group.

Table 1: Demographic characteristics of patients.

	PEX Group (n=53)	Control Group (n=188)
Age, years (mean±SD)	71.47±17.05	65.56±15.36
Range	(47-88)	(41-90)
Gender		
Male	31	100
Female	22	88

Values are expressed as n (%) or mean ± SD, Standart deviation.

The incidence of iris retractor hook implantation was significantly higher in PEX group than control Group ($p=0.001$). Capsule Tension Ring (CTR) were also implanted in 15 (6.22%) patients, 12 (22.6%) of them were in PEX group and only 3 (1.59%) cases were in control group; 4 (7.54%) patients needed both iris retractor hook and CTR implantation all of whom were in PEX Group. The incidence of CTR implantation was significantly higher in PEX group than control group ($p=0.001$).

The mean phacoemulsification ultrasound time (UST) was 80.41 second (sec) and median UST was 84.40 sec (min 8.1–max 198 second) in PEX Group and the mean UST was 71.17 sec and median was 67.50 sec (min 6.5–max 382 sec) in the CG. UST was statistically significantly longer in PEX Group than CG. ($p=0.03$)

The mean effective phacoemulsification time (EFT) was 28.55 sec. and the median was 14 (min 12.2–max 198 sec.) in PEX Group and the mean EFT was 43.29 sec, median was 26.10 sec (min 11.15–max - 330 sec.) in CG. The EFT was statistically significantly shorter in PEX group than CG. ($p=0.008$)

The mean PP was 17.11% and the median was 17.10% (range of 4 to 40%) in PEX group while the mean PP was 17.82% and the median was 17.20% (range of 3 to 40%) in CG. The difference was not statistically significant. ($p=0.32$). Comparison of phacoemulsification parameters in the groups are shown in Table 2.

Table 2: Comparison of phacoemulsification parameters in the groups.

	PEX Group (n=53)	Control Group (n=188)	p*
The mean UST (sec)	80.41	71.17	0.03
The mean EFT (sec)	28.55	26.10	0.008
The mean PP (%)	17.11	17.82	0.32

UST, Ultrasound time; EFT, Effective phacoemulsification time; PP, Phacoemulsification percentage. *Paired sample t-test.

DISCUSSION

Phacoemulsification techniques are developed to restore visual acuity in order to secure and fast return to normal life and it has become the norm for routine cataract surgery even in hard nucleus and in eyes with PEX. All kind of cataract surgeries is associated with some degree of anterior segment tissue trauma.

The extend of surgical trauma depends on several factors including mechanical effects of ultrasound energy, prolonged surgical time, physical trauma by nonaspirated lens fragments, higher nucleus grade and preexisting additional risk factors such as PEX. PEX deposition caused various ocular complications mainly by zonulopathy and phakopathy make phacoemulsification potentially challenging. In eyes combined with PEX and the hard lens requires increased emulsification time, which can result in even more difficult surgery.¹²⁻¹⁵

In this study we compared phacoemulsification parameters and intraoperative risk factors as well as surgical complications in hard cataract between the eyes with PEX and normal subjects. As far as we know this is the first study that evaluate intraoperative manipulations and phaco parameters in eyes combine with PEX and hard nucleus.

Davison and Chylack¹¹ reported exponentially greater phaco energy was required as nucleus hardness increased. Kim et al.,¹⁶ also found a linear positive correlation between the cumulative dissipated energy and nuclear opalescence (NO) and nuclear color (NC) evaluated by lens Opacity Classification score (LOCS). In mentioned studies nuclear grading component of NO and NC did not evaluated separately as we did, because NO and NC were not significantly different in same eyes. Evaluation of cataract density and slitlamp based grading system is a subjective method influenced by the slitlamp setting, amount of illumination, evaluators training level and may have interobserver variation. Each patient evaluated by the same experienced surgeon with the same slitlamp condition and only eyes with hard nucleus with grade 4 included in present study. Holding as many factors as possible constant, while varying less component greatly simplifies the comparison. Therefore we limited our comparative evaluation to phaco parameters and surgical complications while keeping the surgical method, phaco machine, preoperative phaco parameters setting such as duty cycle and surgical materials such as composition of the irrigation solution and VES the same.

Kaljurand and Teesalu¹⁷ reported that phaco time was significantly higher in patients with PEX and Neelam et al.,² also found similar results that, effective phaco time in PEX group (49.70 ± 13.75 sec) was significantly higher than that of the control group (40.20 ± 10.27 sec). According to their opinion this significant difference was probably due to predominance of harder cataracts in PEX group which was equal and/or more than grade 3 using LOCS III classification comparing to the control group, in their study each group consist of 34 eyes. In the present study, the mean phaco time was significantly longer in PEX Group (80.41 sec.) than the CG (71.17 sec) similar to the other reports, but the mean phaco time of each group were longer than that of Neelam et al.s' series. Because in order to compare the phaco parameters in hard nucleus in eyes with or without PEX, we evaluated only the cataracts with grade 4 nuclear hardness, we did not include cataracts with grade 3 hardness as they did, therefore nuclear hardness of our study was higher than their cases.

Yizhi et al.,¹⁹ reported the mean phaco time changes between 138 to 67 sec. and the mean EPT were in range of 11.13 to 3.65 sec in eyes with hard cataract operated with different power modes and different technique which was phaco-chop technique. In whitestaar technology mode they selected the power on duration of 6 msec and a power off duration 12 msec in which, power off duration was longer than our setting so even their mean phaco times were similar to our result, the mean EFTs were shorter than that of ours. The different phaco techniques have different advantages and disadvantages. The type of cataract, patients cooperation in local anaesthesia, nature of the eye such as eyes with short or long axial length, anterior chamber depth, eyes located deep in orbit or eyes with PEX determine the amount of phaco energy and mechanical manipulation for the lens material removal.¹⁸⁻²⁰ Storr-Paulsen et al.,²¹ observed the mean total phaco energy was higher in divide - and - conquer group than the phaco-chop group but they did not give any parameters such as mean phaco time, phaco power or UST. Davison et al.,¹¹ demonstrated that the divide-and-conquer technique delivers more phaco power than phaco-chop technique. On the other hand phaco-chop technique uses more mechanical energy to break nucleus and requires a longer period of nuclear fragments manipulation than divide-and-conquer technique. Excessive manipulation and mechanical stress increase zonular damage mainly in eyes with zonular weakness such as in PEX. That is why we preferred to divide-and-conquer technique in our comparative study. Even the total phaco time was longer in PEX group, the mean EFT was statistically shorter than that of CG. Theoretically less phacoenergy from less EFT makes less stress on delicate structure of the eye such as zonules mainly in eyes with PEX. PEX is associated with a significant increase in intraoperative complications. Zonular weakness and small pupil associated with hard nucleus have been identified as the most important risk factors for surgical complications and might end with significant intraoperative morbidity such as vitreous loss, dropped nuclei or lens fragments.²²⁻²⁴

In the present study, the mean age in PEX group were significantly higher than in control group. In another study the patients with PEX were significantly older than those in non PEX group similar to ours.² Advanced age contributes to weakening of the suspensory apparatus of the crystalline lens and poor pupillary dilatation even in normal eyes only with senile cataract and no coexisting pathology. A well dilated pupil is one of the main requirements for a safe and successful surgery mainly in eyes with zonular fragility. In present study, iris retractor hooks as a pupil stretching devices were used to overcome the problem of insufficient mydriasis in 16 eyes with PEX contrast to only 2 eyes in control group. Capsular tension ring was inserted with a view to avoiding probable complications due to zonular weakness in 12 patients with PEX out of 15 eyes. With the help of these precautions we did not observe any surgical complications like zonular dehiscence, posterior capsular rupture, vitreous loss, and a nuclear drop neither in PEX group nor in CG. Drolsum et al.,²² found a frequency of 9.6% of capsular tear, zonular tear or vitreous loss in eyes with PEX, Neelam et al.,² encountered frequency of 2.9% of zonular dialysis, posterior capsular tear with vitreous loss in eyes with PEX and 0% in non-PEX group.

But Shastri and Vasavada²⁴ and Hyams et al.,⁶ reported no significant difference in the rate of complications between patients with and without PEX, they suggested the complications were partly the result of the inexperience of surgeons who performed the operations. Each operations were performed by the same experienced surgeon in presented study which may cause high success rate in our cases.

Despite the increased surgical risks, improvement in phaco technologies and preventive approaches, with the use of a combination of appropriate devices, the overall outcomes for patients with PEX can be similar to those for non-PEX patients undergoing cataract surgery by an experienced surgeon.

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