



# Early Experience in Femtosecond Laser-Assisted Cataract Surgery

## Femtosaniye Lazer Yardımlı Katarakt Cerrahisinde İlk Deneyimler

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### Summary

**Objectives:** To analyze the early experience and intraoperative complications of femtosecond laser-assisted cataract and refractive lens exchange (RLE) surgery.

**Materials and Methods:** The initial 50 eyes of 29 patients who underwent cataract or RLE surgery between March 2013 and May 2013 were included in this study. All patients underwent anterior capsulotomy, lens fragmentation, and corneal incisions with the femtosecond laser (LenSx®, Alcon Inc.). The operation was completed by phacoemulsification and implantation of an intraocular lens. Intraoperative complications were evaluated from patient charts and video reviews retrospectively.

**Results:** The mean age of the patients included was  $63.8 \pm 11.7$  years. No suction break or anterior capsule tear occurred in any case. Small anterior capsular tags occurred in 11 eyes (22%). The capsulotomy buttons were free-floating in 7 eyes (14%), while capsulorrhexis was partially completed with microadhesions in 40 eyes (60%) and uncompleted in 3 eyes (6%). One eye (2%) had a posterior capsule rupture secondary to increase in the intracapsular pressure. Corneal incisions either were not preferred to be used in 8 eyes (16%) or could not be completed in 4 eyes (8%). Miosis occurred in 20 eyes (40%). No vision lost or dropped nuclei were observed.

**Conclusion:** The use of femtosecond lasers in cataract and RLE surgery is safe. There had been no vision lost secondary to complications. (Turk J Ophthalmol 2015; 45: 97-101)

**Key Words:** Femtosecond laser, cataract surgery, complications

### Özet

**Amaç:** Femtosaniye lazer yardımcı katarakt ve refraktif lens değişimi (RLD) cerrahisinde intraoperatif komplikasyonlar ve ilk deneyimlerin değerlendirilmesi.

**Gereç ve Yöntem:** 2013 Mart-2013 Mayıs tarihleri arasında femtosaniye lazer yardımcı katarakt ve RLD ameliyatı yapılan 29 hastanın 50 gözü çalışmaya alındı. Tüm hastalara Femtosaniye lazer cihazı (LenSx®, Alcon Inc.) ile komple prosedür (kapsülotomi, lens fragmentasyonu ve korneal kesiler) uygulandı. Ameliyatlar fakoemülsifikasyon ve göz içi lensi yerleştirilerek tamamlandı. İntraoperatif komplikasyonlar retrospektif olarak hasta dosyalarından ve ameliyat videolarından değerlendirildi.

**Bulgular:** Hastaların yaş ortalaması  $63,8 \pm 11,7$  (SD) yıl idi. Vakum kaybı ya da anterior kapsül yırtığı hiçbir gözde oluşmadı. On bir gözde (%22) küçük ön kapsül etiketleri oldu. Yedi gözde (%14) serbest kapsülotomi, 40 gözde (%60) mikroadezyonlarla birlikte parsiyel tamamlanmış kapsülöreksis ve 3 gözde (%6) inkomplet kapsülöreksis izlendi. Bir gözde (%2) intrakapsüler basınç artışına bağlı arka kapsül rüptürü gelişti. Korneal kesiler 8 gözde (%16) kullanılmak istenmedi, 4 gözde (%8) tamamlanamadı. Miyozis 20 gözde (%40) meydana geldi. Vizyon kaybı ya da nükleus drop gözlenmedi.

**Sonuç:** Femtosaniye lazerlerin katarakt ve RLD cerrahisinde kullanımı güvenlidir. Komplikasyonlara bağlı görme kaybı gelişmemiştir. (Turk J Ophthalmol 2015; 45: 97-101)

**Anahtar Kelimeler:** Femtosaniye lazer, katarakt cerrahisi, komplikasyonlar

## Introduction

The advances in surgical cataract techniques and intraocular lens (IOL) technology continue developing to provide better visual quality for patients. With the higher patient expectations and the increasing use of premium IOLs, refractive outcomes of cataract surgery become more important.<sup>1,2,3</sup>

Femtosecond (FS) laser technology has been used in refractive surgery to perform lamellar flaps in laser in situ keratomileusis (LASIK) since 2001.<sup>4,5</sup> Several studies have reported the potential advantages of FS lasers over the other lasers used in ophthalmology because of its ultrashort pulse duration (1015 seconds).<sup>6,7</sup> The first use of FS lasers in cataract surgery was in 2008.<sup>8,9</sup> Anterior capsulotomy, lens fragmentation, and corneal incisions can be made by the FS lasers during cataract surgery. FS laser-assisted cataract surgery gives surgeons a new option to potentially improve patient outcomes, safety, and accuracy. The procedure has been reported to be generally safe with low complication rates. However, FS laser-assisted cataract surgery presents a unique set of clinical challenges especially during the learning period. Radial capsule tears, posterior capsule tears, and dropped nuclei are the most important complications of FS laser-assisted cataract surgery.<sup>10</sup>

Precisely located and architected corneal incisions for paracentesis and IOL implantation can be created by FS lasers.<sup>11</sup> They also provide predictable astigmatism outcomes by performing on-axis placement of the main incision and arcuate relaxing incisions.

FS laser-assisted cataract surgery has a learning curve. Most of the complications occur in this learning period. Therefore, we aimed to report our first 50 cases. In this present study, we evaluated our initial experience, intraoperative complications and their managements during FS laser-assisted cataract surgery.

## Materials and Methods

The present study was a single-center, retrospective, and case series study. Fifty eyes of 29 patients who underwent FS laser-assisted cataract or refractive lens exchange (RLE) surgery between March 2013 and May 2013 at Kaşkolğlu Eye Hospital were included in the study. Data were collected from patient charts and surgical videos retrospectively. After an in-depth discussion about the risks and benefits of the procedure, all patients gave their informed consent.

All patients underwent a detailed preoperative assessment, including slit-lamp biomicroscopy, tonometry, as well as measurement of corrected distance visual acuity and manifest refraction. Cataract investigations included measurement of axial length and biometry (IOL master, Carl Zeiss Meditec AG), corneal topography (Pentacam, Oculus, Inc.), and specular microscopy (Noncon Robo SP-9000, Konan Medical). Patients with corneal opacities or poorly dilating pupils (<5 mm) limiting visualization of the anterior segment and anterior capsule, advanced glaucoma, and narrow palpebral fissures were excluded from the study.

All the procedures were performed by two surgeons (B.S.A., M.K.) who were experienced in cataract and FS LASIK under topical anesthesia. Pupillary dilation was achieved before surgery

with 1.0% tropicamide (tropicamide) and 2.5% phenylephrine hydrochloride (mydrin). The laser procedure was started with the disposable patient interface docking to the eye by taking care of corneal centralization. The anterior capsulotomy, nuclear-fragmentation, and primary and side-port corneal incisions were then created using the LenSx laser (Alcon, Fort Worth, TX) under OCT image control. A 2.3 mm three-plane trapezoidal clear corneal incision and two 1.2 mm 30 degree cut angle side ports were created. A 4.5-5.2 mm diameter capsulotomy was created by scanning a cylindrical pattern, and the lens was fragmented into quadrants. Proprietary energy and spot separation parameters were used in all laser procedures. Energy=15 µJ (microjoule), spot separation=4 micron, layer separation=3 micron. After the completion of the laser procedure, the laser-created corneal incisions were dissected bluntly with spatula. An ophthalmic viscosurgical device (OVD) (1.65% sodium hyaluronate-4% chondroitin sulfate, Discovisc) was injected into the anterior chamber. If miosis developed after the laser procedure, intracameral adrenalin (1: 10.000) was also injected. The capsulotomy was removed with a capsulorrhexis forceps. After hydrodissection, fragmentation, and phacoemulsification of the nucleus, aspiration of the residual cortex was performed using an Infiniti phaco machine (Alcon Laboratories, Inc). All IOLs were folded and implanted in the capsular bag. After IOL implantation, the OVD was removed from the anterior chamber and capsular bag by irrigation/aspiration (I/A).

The standard postoperative regimen included 1 drop of combined dexamethasone 1mg/ml-tobramycin 3mg/ml eyedrops (tobradex) 4 times a day for 2 weeks. The patients were followed up at day 1, day 7, and 4 weeks after surgery.

## Results

A total of 50 consecutive cataract/RLE surgeries performed with the LenSx FS laser were included in the study. Baseline and demographic parameters are shown in Table 1. The grades of the cataracts are given in Table 2. The mean of preoperative and postoperative corrected distance visions were  $0.44 \pm 0.29$  LogMAR (range 1.00- 0.00 LogMAR) and  $0.04 \pm 0.61$  LogMAR (range 0.18-0.00 LogMAR), respectively. Table 3 shows the visual acuity results for each group. None of the cases had vision lost. The mean of the intraocular pressure at 1 month was  $16 \pm 2$  mmHg.

In 46 eyes of 25 patients (92%), a complete consecutive sequence of capsulotomy, lens segmentation, and main and side-port corneal incisions were successfully completed with the FS laser. There had been no suction break during FS laser-assisted cataract or RLE surgery. After the patients were transferred to the operating room, miosis was seen in 20 eyes of 17 patients (40%). In addition to routine preoperative dilating drops, intracameral adrenalin (1: 10.000) was injected into the anterior chamber to redilate these eyes. A free-floating capsulotomy was present in 7 eyes of 5 patients (14%). The anterior capsulotomy button was incomplete in 3 eyes of 3 patients (6%) and a manual capsulorrhexis was required to complete the capsulotomy.

The other 40 (60%) required slight manual manipulation for removal. Small anterior capsular tags were seen in 11 eyes of 10 patients (22%) after removal of the capsulotomy button. In none of the eyes, capsular tags led to extension and formation of radial anterior capsular tears. One eye of 1 patient (2%) had capsular blockage syndrome with consecutive posterior capsule rupture. There was minimal vitreous loss. There were no cases of dropped nuclei or required vitrectomy. In 4 eyes of 4 patients (8%), corneal incisions could not be completed due to air/fluid (3 eyes of 3 patients) and conjunctiva/fluid (1 eye of 1 patient) interface. In 8 eyes of 7 patients (16%), we did not use the corneal incisions completed by the FS lasers because in 5 eyes of 5 patients (10%), the corneal incisions were located too anterior

(in 1 eye main and in 4 eyes side-port corneal incisions) and in 3 eyes of 2 patients (6%), the corneal incisions were at the limbus (3 side-ports). In 19 eyes of 15 patients (38%), conjunctival injection or hemorrhages happened at different levels (Table 4).

In Table 5, the results of complications according to the grade of the cataract are given and also all of the complications are summarized.

### Discussion

This present study evaluates our initial experiences and intraoperative complications in FS laser-assisted cataract and RLE surgery. Most of the complications occurred in our first 50 cases during our learning curve. No serious complication that could lead to vision loss was observed due to the fact that the surgeons became familiar with the technology.

Greater architectural stability and reproducibility at corneal incisions with FS laser in cadaver eyes were reported by Masket et al.<sup>11</sup> With the improving capacity to pre-position the laser treatment patterns of the LenSx system, main, side-port, and astigmatic relaxing corneal incisions could be placed on any

**Table 1. Baseline demographic data of the patients**

Parameter	Value
Age (yrs)	
Mean ± SD	63.8±11.7
Range	43-82
Sex	
Male/Female (n)	15/14
Eyes	
Right/Left (n)	24/26
BCDVA (LogMAR)	
Mean ± SD	0.47±0.35
Range	0.00-1.30
Axial Length (mm)	
Mean ± SD	23.28±0.97
Range	21.69-25.00
Average Ks (D)	
Mean ± SD	43.78±1.60
Range	39.50-46.75
Average ACDs (mm)	
Mean ± SD	3.02±0.32
Range	2.24-3.75
IOL implanted (n)	
Nontoric monofocal	17
Toric monofocal	11
Nontoric multifocal	16
Toric multifocal	6
IOL power (D)	
Mean ± SD	22.02±2.33
Range	17.00-26.50

Yrs: Years, SD: Standard deviation, BCDVA: Best-corrected distance visual acuity, D: Diopter, ACD: Anterior chamber depth, IOL: Intraocular lens, n: Number

**Table 2. Grade of cataract opalescence according to the Lens Opacities Classification System III**

Grade I	3 eyes (7.5%)
Grade II	20 eyes (50%)
Grade III	15 eyes (37.5%)
Grade IV	2 eyes (5%)

**Table 3. Visual outcomes**

Eyes n (%)	Postoperative corrected distance visual acuity (LogMAR)
4 (8%)	0.20-0.18
46 (92%)	0.10-0.00

**Table 4. Grades of conjunctival injection and hemorrhages**

	Conjunctival Injection n=13 eyes (9 patients)	Conjunctival Hemorrhages n=6 eyes (6 patients)
1 quadrant	7 eyes	4 eyes
2 quadrants	3 eyes	2 eyes
3 quadrants	2 eyes	none
4 quadrants	1 eye	none

**Table 5. Complications according to the grade of the cataract**

Grade	Miosis n (eyes)	Anterior capsule tags n (eyes)	Free floating capsulotomy n (eyes)	Partial capsulotomy n (eyes)	Capsular block syndrome n (eyes)	Uncompleted corneal incisions n (eyes)	Completed but not used corneal incisions n (eyes)
I	2	-	1	-	-	-	2
II	6	4	2	1	-	2	3
III	9	4	-	2	1	1	2
IV	-	2	-	-	-	1	1

desired axis. Corneal wounds and arcuate incisions in the desired position and at the desired depth in the cornea provide less postoperative astigmatism and also give a chance to treat preoperative astigmatism.<sup>12</sup> However, during corneal incision creation with the femtosecond laser, if the incision is too anterior, it can cause surgically induced astigmatism, or if the incision is too peripheral, it cannot be opened secondary to the conjunctiva blocking. In the current study, in 4 eyes (8%) corneal incisions could not be performed with FS laser due to air/fluid (3 eyes) and conjunctiva/fluid (1 eye) interface. In 5 eyes, corneal wounds (1 main incision and 4 side-ports) were too anterior that we did not want to use, and in 3 eyes (3 side-ports) could not be opened because of their limbal positions. It is important to take care of centralization in order to properly locate the corneal incisions. Especially in older patients, loose conjunctiva should be considered.

Some studies report that suction break can be a common intraoperative complication during the learning curve early.<sup>12,13</sup> In a study including 1500 cases, the rate of suction breaks improved significantly compared with the early experience group (0.61% vs. 2.5%).<sup>10</sup> In this study, no suction break was noted during the procedure. The main risk factors for suction break are inadvertent movement of the patient's head or eye, improper docking, a small palpebral fissure, incompatible patients, inadequate anesthesia, and loose conjunctiva around the limbus. Therefore, preoperative patient evaluation is very important.

Miosis after laser procedure is an important factor that makes surgery more difficult. Several studies noted miosis rates between 10-32%.<sup>10,12,14</sup> Bali et al.<sup>12</sup> used tropicamide 1.0%, phenylephrine 10.0%, and cyclopentolate 1.0% for pupil dilation, and miosis was noted in 9.5% eyes. Roberts et al.<sup>10</sup> suggest that use of phenylephrine 10.0% immediately after the laser treatment could decrease the rates of miosis (from 9.5% to 1.2%). In the present study, a relatively high rate of pupil constriction (40%) was observed after the laser procedure. Intracameral adrenalin (1: 10,000) was injected into the anterior chamber to redilate these eyes. No mechanic dilatation was required. Apposition with the patient interface, shockwaves created by the laser hitting the pupillary border, and lapse of time between the laser procedure and the phacoemulsification might cause pupillary constriction. Hitting the pupillary border can be avoided with a careful observation of the pupil during the laser treatment. Use of preoperative topical nonsteroidal drugs could be an effective way to prevent miosis. It is thought to decrease the inflammatory response due to laser energy.

Providing a properly sized, shaped, and centered anterior capsulotomy is one of the most important advantages of FS laser.<sup>15</sup> Incomplete capsulotomy rates are reported ranging from 1.0% to 10.5% in the literature. In this study, a manual capsulorrhexis was required to complete the capsulotomy in 3 eyes (6%). Anterior capsule tags are usually harmless if the surgeon notices them in time. A slow and cautious anterior capsule removal with a capsulotomy forceps can avoid anterior tear. The incidence of anterior capsule tags was 22% (11 eyes) in our study which is within the reported range of 10.5% to

20%.<sup>8,12</sup> One of the most serious anterior capsule complications of FS laser is anterior capsule tear. None of the eyes included in this study had anterior tear. In the literature, anterior capsule complication rates are ranging from 4% to 5.3%.<sup>12,13,14</sup> The crucial step is not to pull out the anterior capsule with a sudden movement. The surgeon should ensure the capsule is absolutely free. If an anterior tear is observed, gentle hydrodissection and phacoemulsification should be performed. Otherwise, posterior capsule damage with possible nucleus drop may occur.

The most serious complication reported in FS laser-assisted cataract surgery is capsular block syndrome so far. Capsular block syndrome was described firstly by Roberts et al.<sup>16</sup> The authors reported posterior capsule rupture and dropped nuclei after hydrodissection in their first 50 cases. One of our cases also had elevated intracapsular pressure and posterior rupture after hydrodissection. With minimal vitreous loss, a foldable IOL was implanted in the bag and there was no dropped nucleus. Roberts et al.<sup>16</sup> underlined having hydrodissection very carefully and slowly in order to avoid this complication. After this caution, they observed no capsular block syndrome in their series. Management of hydrodissection is one of the main steps of the learning curve in FS-assisted cataract surgery. Predisposing factors are inadequate OCT images, intense gas bubbles, and rapid hydrodissection.<sup>16,17</sup>

A mild circumferential subconjunctival hemorrhage, generally resolved within a week, may be induced by the intraocular pressure increase during the laser treatment. We observed subconjunctival hemorrhages or conjunctival redness in 19 eyes (38%) at different levels. Chang et al.<sup>14</sup> reported subconjunctival hemorrhage approximately in 50% of eyes in their study. They found a correlation between subconjunctival hemorrhage and redocking, but not with age or use of an antiplatelet drug. They also suggested that prolonged strong suction time of the suction ring during the laser procedure might be a leading factor for subconjunctival hemorrhage. From our observations, anticoagulant medications are also leading factors for subconjunctival hemorrhage. However, it is not necessary to discontinue anticoagulant medications.

No patient included in this study had loss in visual acuity. FS laser-assisted cataract/RLE surgery is safe and effective technique. After the learning curve, intraoperative complications will be less. Surgeon's experience with the FS laser will also help to shorten the learning period.

Major limitation of this study is the small number of cases. Other limitations are the uncontrolled fashion and retrospective design. We suggest increasing the number of cases, comparing intraoperative complications between the initial 50 eyes that had already been presented and the eyes undergoing FS laser-assisted cataract/RLE surgery in our future studies.

FS lasers have potential advantages and also intraoperative complications. However, these complications can be avoided with careful surgery and experience. Future studies will present much more evidence on the precision, reproducibility, and refractive benefits of FS laser.

**Conflict of Interest:** The authors reported no conflict of interest related to this article.

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