Original Article

Preliminary Results of Femtosecond Laser-assisted Cataract Surgery in a Private Clinic in Iran

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Abstract

Purpose: To report the preliminary results of femtosecond laser-assisted cataract surgery in Iranian patients.

Methods: This prospective case series included 21 eyes of 21 patients with cataract. Mean patient age was 66.7 ± 10 years. The patients underwent femtosecond-laser assisted cataract surgery (VICTUS Femtosecond Laser Platform: Bausch + Lomb) and intraocular lens (IOL) implementation in Bina Eye Hospital, Tehran, Iran between May and October, 2014. Visual outcomes, intraocular pressure (IOP), and complications were evaluated three months after surgery.

Results: Mean preoperative best-spectacle corrected visual acuity (BSCVA) was 0.40 ± 0.21 logMAR which significantly improved to 0.02 ± 0.03 logMAR three months postoperatively ($P < 0.001$). Mean preoperative IOP was 17.88 ± 2.70 mmHg which significantly decreased to 12.5 ± 1.51 mmHg three months after operation ($P < 0.001$). Mean duration of operation for these patients was 29.30 ± 8 minutes and mean femtosecond laser process time was 4.20 ± 2 minutes. In terms of complications, 9 patients developed fine subconjunctival hemorrhage and eye redness and 2 patients had mild corneal edema which all subsided within less than 7 days. Serious complications such as anterior or posterior capsule tears were not encountered.

Conclusion: Femtosecond laser-assisted cataract surgery is a relatively new method of cataract surgery. Our preliminary results indicate an acceptable visual outcome with no serious complications. However, this technique is lengthier and more expensive than conventional phacoemulsification.

Keywords: Femtosecond; Cataract; Surgery; Iran

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Access this article online	
Quick Response Code:	**Website:** www.jovr.org
	DOI: 10.4103/jovr.jovr_70_16

INTRODUCTION

Femtosecond laser has been used since 2001 for laser *in-situ* keratomileusis refractive surgery to create the corneal flap in place of a microkeratome.[1] The use of femtosecond laser in cataract surgery is a relatively

How to cite this article: Nejat F, Sarahati S, Mojaled Nobari S, Jadidi Kh, Naderi M, Nejat MA. Preliminary results of femtosecond laser-assisted cataract surgery in a private clinic in Iran. J Ophthalmic Vis Res 2017;12:39-43.

new application which was first performed clinically by Professor Zoltan Nagy in Budapest, Hungary.[2] Femtosecond laser is able to create a nearly perfect and round opening in the anterior capsule and precise main clear corneal and side-port incisions. Femtosecond laser-fashioned capsulotomy, probably has several potential advantages over the manual capsulorhexis.[3,4] Furthermore, femtosecond laser can fragment the crystalline lens by applying pulses to the lens nucleus, hence reducing the average time required for lens removal.[5]

Femtosecond laser-assisted cataract surgery has been designed to provide better visual outcomes and reduce the odds of intraoperative complications. Considering the visual outcomes, in a recent and large comparative study by Ewe et al among 1876 eyes from 1238 patients, they did not detect clinically improved outcomes among patients undergoing femtosecond surgery compared to patients undergoing phacoemulsification cataract surgery.[6] But in another comparative study by Conrad-Hengerer et al patients undergoing laser-assisted cataract surgery yielded faster visual recovery, less deviation from the target refraction, and earlier stabilization of refraction.[7]

A study by Roszkowske et al showed that femtosecond laser produced consistent and stable incisions which is attributable to the controlled and reproducible creation of the incisions with an appropriate configuration.[4] A study by Al Mahmood et al reported that the length and the shape of the incision are not predictable when a manual blade is used. This may lead to wound leak and an increase in the potential risk of infection.[3] Another study by Nagy et al reported that the femtosecond laser-assisted procedure also entails intraoperative complications, including conjunctival redness or hemorrhage, capsule tags or bridges, miosis, and suction break andanterior tear. These complications, however, are preventable.[8]

To our knowledge, no previous study has investigated the preliminary outcomes of femtosecond laser-assisted cataract surgery in Iran. The present study was aimed to report the preliminary results in patients who were operated by this method in our center.

METHODS

This retrospective interventional case series included 21 eyes (13 right and 8 left eyes) of 21 patients with moderate to severe cataract (nuclear sclerosis + 4 and higher) who underwent femtosecond laser-assisted cataract surgery (VICTUS Femtosecond Laser Platform: Bausch + Lomb, USA) and intraocular lens (IOL) implementation between May, 2014 and October, 2014 in Bina Eye Hospital, Tehran, Iran.

The inclusion criteria were patients older than 50 years with a non-complicated senile cataract, and the exclusion criteria consisted of dilated pupil diameter less than

5 mm, corneal scarring, steep cornea (above 47 diopters (D)), advanced glaucoma, patients with filtering bleb or Ahmed glaucoma valve implantation, patients with deep orbit or deep set eyes, skeletal diseases preventing the patients from positioning in complete supine position, corneal ring inlays, floppy iris syndrome, intumescent cataract and previous refractive surgery.

Complete ophthalmic examinations including best-spectacle corrected visual acuity (BSCVA), intraocular pressure (IOP) measurement (Goldmann applanation tonometry), and refraction were performed preoperatively and 3 months postoperatively. Anterior and posterior segment examinations were done with undilated and dilated pupils, respectively. Biometry including keratometry, axial length, and anterior chamber depth measurement using partial coherence interferometry (IOLMaster 4, Carl Zeiss Meditec AG, Germany) was performed. Preoperatively, tropicamide 1% eye drop was applied three times every five minutes together with a single drop of phenylephrine 5%. All procedures were performed under topical anesthesia using tetracaine 0.5%. The laser settings were consistent for the duration of the study, and the software versions were up to date at the time of study. The diode-pumped solid-state femtosecond laser operates at a wavelength of 1000 nm and pulse duration of 600 fs. For anterior capsulotomy, the incision depth was 800 μm, the horizontal spot spacing was 5 μm, the vertical spot spacing was 10 μm, and the pulse energy was 4 μJ. For lens fragmentation, the posterior capsule safety zone was 500 μm, the horizontal spot spacing was 10 μm, the vertical spot spacing was 40 μm and the pulse energy was 8 μJ anteriorly and 10 μJ posteriorly.

The cataract surgery was performed by one surgeon (Kh-J). Predefined surgeon templates were used for the selection of anterior capsulotomy and lens fragmentation patterns. The fragmentation pattern consisted of 8 radial cuts and for lens softening a circular pattern with six cuts was used. The surgeon confirmed the accuracy, location, and size of the anterior capsulotomy, and lens fragmentation architecture, before laser treatment, using high resolution video and anterior segment spectral domain optical coherence tomography (OCT) imaging. The OCT imaging also allowed the detection of posterior capsule and iris margin safety zones. The number of vacuum attempts and treatment times were recorded. Patients were then transferred to the operating room for regional anesthesia and completion of the surgery. Corneal incision was performed using femtosecond and then the canal was opened using a knife. The anterior chamber was filled with sodium hyaluronate 3.0%–chondroitin sulfate 4.0% (Viscoat, Alcon, USA). The anterior capsule was removed using a capsulorhexis forceps following the contour of the laser capsulotomy in a continuous curvilinear fashion. Subsequently, cautious

hydrodissection was performed with low volumes of fluid using a rock and roll technique to ensure the release of intracapsular gas, and to avoid exertion of excessive pressure through the cannula and hence capsular block. Lens segmentation was performed using a divide-and-conquer approach. Surgery was then completed using standard phacoemulsification procedures (Infiniti Machine, Alcon, USA), followed by IOL Envista implantation in the capsular bag after successful removal of the lens cortex.

Intraoperative complications were recorded on the surgical report and included the presence of corneal haze affecting the surgeon's view at any time point, laser-induced miosis, anterior capsulotomy tag, tear in the anterior or posterior capsule, posterior capsule rupture, vitreous loss, and IOL dislocation.

Visual acuity was expressed in logMAR. Continuous and categorical variables were expressed as mean ± SD and frequency (percentages), respectively. Preoperative and 3 month postoperative visual acuity and IOP were compared using paired *t*-test. All statistical analyses were performed using SPSS software (IBM SPSS statistics for windows, version 20.0; Armonk, NY: IBM corp., USA).

RESULTS

In this study, 21 eyes of 21 patients including 12 (57%) female and 9 (43%) male subjects with the mean age of 66.70 ± 10 years (range 51 to 82) were included [Table 1]. Mean duration of total operation and femtosecond laser treatment were 29.30 ± 8 and 4.20 ± 2 minutes, respectively [Table 1]. The IOL power was between 19 and 22.50 D. Mean uncorrected visual acuity (UCVA) significantly improved from 0.77 ± 0.53 logMAR preoperatively to 0.07 ± 0.08 logMAR at 3 months postoperatively (P < 0.001) [Table 2]. Preoperative mean BSCVA was 0.40 ± 0.20 logMAR which statistically significantly improved to 0.02 ± 0.03 logMAR 3 months after surgery (P < 0.001) [Table 2]. Mean IOP was 17.87 ± 2.70 mmHg preoperatively which was reduced to 12.50 ± 1.51 mmHg at 3 months postoperatively (P < 0.001). Considering the complications, 9 patients developed fine subconjunctival hemorrhage and 2 patients showed mild corneal edema which subsided before the end of the first postoperative week. One patient needed a second suction which was performed successfully [Table 3].

DISCUSSION

This relatively small single-center case series evaluated the outcomes of femtosecond laser-assisted cataract surgery among Iranian patients. To our knowledge, this is the first report of femtosecond laser-assisted cataract surgery outcomes from Iran. Our patients had a significant improvement in their UCVA and BCVA three months after surgery and showed a significant

Table 1. Baseline characteristics of patients with senile cataract entering the study

Parameter	Mean±SD/N (%)
Age (years)	66.70±10
Sex (numbers (%))	
Male	9 (43)
Female	12 (57)
Duration of total operation (minutes)	29.30±8
Duration of femtosecond laser treatment (minutes)	4.20±2

SD, Standard deviation; *N*, Number

reduction in postoperative IOP. We also documented the complications in our small group of patients, which included only fine subconjunctival hemorrhage in 9 patients and mild corneal edema in 2 patients.

Some reports have indicated that caution should be taken during cataract surgery using femtosecond laser after early adaptation of the method in order to avoid capsular tears.[9,10]

We did not encounter this complication which can be attributed to the small sample size and the fact that the surgeon had already overcome the learning curve. Since the rate of anterior and posterior capsule tear is 2% and 0.5% in femtosecond laser-assisted cataract surgery, a larger sample size is required to further evaluate the rate of this complication among Iranian patients.

It has been suggested that surgeons can overcome the learning curve required for femtosecond laser-assisted cataract surgery after the operation of 100 cases.[11] In their initial study, Bali et al[12] reported a number of complications in the first 200 cases after early installation of the femtosecond laser. These complications occurred during or immediately following the surgery; however, the majority of these complications had no impact on the visual outcome. In the later study, the same group published their findings over the subsequent 1500 surgeries and concluded that femtosecond laser-assisted cataract surgery, was at least as safe as, and in many cases safer than conventional phacoemulsification.[13] The reduction in the complication rates was likely the consequence of improvements in surgical techniques and surgeons' experience.

We did not encounter any serious complications in this case series, indicating that with caution and in experienced hands, major complications can be avoided even during the learning period. We also found that this procedure in average takes 29.30 ± 8 minutes from start to completion, which seems to be longer than the time required for the classic method. This might be due to the fact that this procedure requires two settings.

The main shortcomings of the present study were the small sample size and lack of a control group undergoing conventional phacoemulsification. It is advisable to conduct a randomized study with a larger sample size

Table 2. Comparison of preoperative BCVA and IOP with three months postoperative measurements						
Variable	Pre	Post	Difference	P*	95% CI	
					Lower	Upper
IOP						
Mean±SD	17.88±2.70	12.50±1.51	5.38	P<0.001	3.00	7.80
Median (IQ: 25-75)	17.50 (16.00-20.50)	12.50 (11.25-14.00)				
Range	14-22	10-14				
BCVA						
Mean±SD	0.40±0.21	0.02±0.03	0.38	P<0.001	0.28	0.47
Median (IQ: 25-75)	0.40 (0.24-0.49)	0.00 (0.00-0.04)				
Range	0.15-1.00	0.00-0.10				
UCVA						
Mean±SD	0.77±0.53	0.07±0.08	0.70	P<0.001	0.47	0.93
	0.70 (0.40,1.00)	0.04 (0.00,0.09)				
	0.15-2.00	0.00-0.30				

CI, confidence interval; SD, standard deviation; IQ, interquartile; BCVA, best corrected visual acuity; IOP, intraocular pressure; UCVA, uncorrected visual acuity; Pre, preoperative; Post, postoperative; *based on paired *t*-test

Table 3. Individual findings for each patient entering the study								
Patient's Code	UCVA		BCVA		IOP		Subconjunctival hemorrhage	Corneal Edema
	Pre Operation	Post Operation	Pre Operation	Post Operation	Pre Operation	Post Operation		
1	0.2	0.8	0.4	1	18	12	+	-
2	0.5	1	0.5	1	18	10	-	+
3	0.3	0.9	0.3	0.9	14	14	-	-
4	0.1	0.8	0.3	1	16	12	+	-
5	0.4	0.9	0.6	1	21	14	+	-
6	0.3	1	0.4	1	16	11	-	-
7	0.1	0.8	0.2	0.9	22	14	-	-
8	0.7	1	0.8	1	16	13	-	-
9	FC at 5m	0.8	0.2	0.9	14	13	+	-
10	0.2	1	0.2	1	15	15	-	+
11	0.5	0.8	0.5	1	12	13	+	-
12	0.4	0.5	0.4	0.8	13	12	+	-
13	0.2	0.9	0.2	1	16	14	-	-
14	FC at 1m	0.8	0.3	0.8	21	20	-	-
15	0.1	1	0.2	1	10	9	+	-
16	0.6	1	0.6	1	19	19	-	-
17	0.2	0.9	0.3	1	14	13	-	-
18	0.1	0.8	0.4	1	18	15	-	-
19	0.3	0.9	0.4	0.9	20	18	+	-
20	FC	0.6	0.3	0.9	18	18	-	-
21	0.4	1	0.5	1	17	15	+	-

BCVA, best corrected visual acuity; IOP, intra ocular pressure; UCVA, uncorrected visual acuity; FC, finger count; Pre, preoperative; Post, postoperative

to further study the outcomes of this method compared to classic cataract surgery among Iranian population.

In conclusion, femtosecond laser-assisted cataract surgery is a relatively new method particularly in Iran. Our preliminary results showed acceptable visual outcomes with no serious complications. It also seems that this method takes more time to complete compared to conventional phacoemulsification. The higher cost of equipment for femto-cataract and its low availability in Iran should be noted when deciding the course of treatment for cataract patients.

Conflicts of Interest

There are no conflicts of interest

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