Romanian Journal of Ophthalmology, Volume 59, Issue 1, January-March 2015. pp:38-42

GENERAL ARTICLE

THE ADVANTAGES OF FEMTOSECOND LASER-ASSISTED CATARACT SURGERY

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Accepted: March 15, 2015

Abstract
Purpose: To present the advantages of performing femtosecond laser-assisted (Alcon-LenSx Inc.) cataract surgery.
Methods: Cataract surgery was performed with the LenSx femtosecond laser (Alcon-LenSx Inc.) in 50 eyes of 50 patients. The laser was programmed to perform a 4,9-4,5 mm capsulorhexis, a 2,3 mm main corneal incision, two 1,3 mm side-port incisions and either a hybrid-pattern or a cylinder-pattern fragmentation of the nucleus. The evaluated parameters were the capsulotomy, the corneal wounds and the nucleus fragmentation. Phacoemulsification of the nucleus and aspiration of the cortex were performed with the Alcon Centurion Vision System and monofocal, toric and multifocal IOLs were successfully implanted.
Results: A continuous, central, curvilinear capsulorhexis was performed in 48 cases, 96% (free-floating capsulotomy). In 2 cases, micro-adhesions were reported and detached with the Utrata forceps. Femtolaser capsulotomy resulted in a complete overlap of the anterior capsule over the IOL optics in all cases. Horizontal decentration was found in 2 cases, 4% and vertical decentration in 1 case, 2%. The main corneal incision was self-sealing in 49 cases, 98%. Sutures were used in 1 case, 2%. The hybrid pattern of nucleus fragmentation was used in 42 cases, 84% and the cylindrical pattern in 8 cases, 16%. The fragmentation was incomplete in one case of white cataract and in one case of traumatic cataract.
Conclusions: The main advantages of femtolaser cataract surgery are standardized corneal incisions, perfectly centered, round capsulorhexis, and lens nucleus fragmentation even in eyes with hard cataracts. The laser precision is due to the real time OCT software programs, which cover the whole anterior segment, up to the posterior lens capsule.
Keywords: cataract surgery, femtosecond laser

Introduction

Four years ago, when the femtolaser technology entered the field of cataract surgery, it aroused much controversy among ophthalmologists. Some surgeons considered that manual phacoemulsification is a perfectly controlled technique, combining microincisions, fluidics regulation and refined micro-instrumentation and guaranteeing a high level of predictability, adjustability and safety. So what could be the interest in introducing a laser that would make the platform heavier? [**1**].

Reflecting over the past, surgeons remembered that even the transition from EEC

to phacoemulsification implied a lot of skepticism, since it required the acquisition of new, expensive machines and materials and a long learning curve. Nowadays, every cataract surgeon performs this technique successfully [**2**].

While the transition from EEC to phacoemulsification, from removing the whole crystalline lens to fragmentation and aspiration of the nucleus, represented a revolution, femtosecond laser-assisted cataract surgery is no revolutionary concept, but it introduces the most advanced technology, which renders all critical steps of phacoemulsification into a consistent, safe and predictable procedure.

Femtolaser surgery becomes the ideal solution for patients who desire newer, advanced technology intraocular lenses (IOLs) by maximizing their benefit, since the refractive results depend upon a perfectly centered capsulotomy and implant positioning.

Purpose

The aim of our study was to present the advantages of performing femtosecond laser-assisted cataract surgery by using the Alcon LenSx femtolaser.

Patients and methods

Patients

A prospective case series included fifty eyes of fifty patients with cataract undergoing femtosecond laser-assisted cataract surgery from March 1st to July 1st 2014 at Laser-Optisan Clinic, Cluj-Napoca, Romania (**Fig. 1**).

Fig. 1 Laser Optisan team

Patients were interviewed for confirmation of ocular, systemic and medical history. All patients signed an informed consent.

Inclusion criteria were age between 37 and 91 years, pupil dilation at the preoperative examination of at least 7 mm, grade I-IV nuclear cataract (Lens Opacities Classification System). Exclusion criteria were weak zonules (zonular dialysis over 45°), failure of pupillary dilation (< 7 mm), history of uveitis and history of retinal detachment surgery.

The preoperative ophthalmic examination included: clinical data, refraction, uncorrected (UCVA) and best corrected visual acuity (BCVA), intraocular pressure, slit-lamp examination of the anterior and posterior segment, lenticular status with opacity grading, corneal topography, endothelial cell count, optical or ultrasound biometry, macular OCT (except for advanced cataracts), B-scan ultrasonography in hard cataracts.

The following examination protocol was applied postoperatively: visual acuity, refraction, intraocular pressure, slit-lamp examination with the localization of the capsulotomy and IOL centration, fundus examination. All patients were evaluated on the first day after surgery and after one, three and six months postoperatively.

Surgical technique

Surgeries were performed by the same surgeon (MMG) at Laser-Optisan Clinic Cluj-Napoca, Romania, by using Alcon LenSx (**Fig. 2**) to perform a 2,3 mm clear corneal primary incision, two 1,3 mm side-port incisions, a 4,9-4,5 mm capsulorhexis and the fragmentation of the nucleus by using either the hybrid pattern or the cylindrical pattern of photodisruption.

Fig. 2 LenSx Laser Image

The laser pretreatment and the standard phaco were performed in the same operating room. Topical anesthesia (oxibuprocaine 0,4%) was used in 49 cases and peribulbar anesthesia was performed in one case only (xylocaine 2%). Tropicamide 1%, cyclopentolate 0,50% and neo-synephrine 10% one drop at every 15 minutes, 60-90 minutes prior to the surgery, were used for pupil dilation.

The docking was the first step of the femtolaser-assisted cataract surgery and it determined the safety and the accuracy of the entire procedure. Once it was properly done and the position of the eye was checked on the screen, suction was applied by simply pressing a button (**Fig. 3**).

Fig. 3 Docking procedure

The next step was to center the treatment plan on the screen (**Fig. 4**).

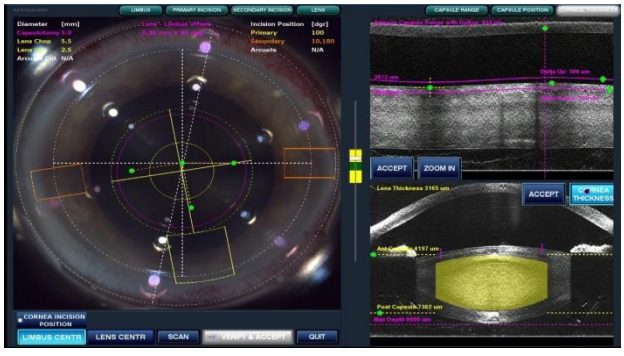

Fig. 4 Treatment plan

First, the incisions had to be placed. Once the corneal incisions were designed in location, length and width, we were able to focus on the capsulotomy. The size of the capsulorhexis could be chosen according to the IOL optic center and the pupil diameter while paying attention to the iris border. After determining the size, the capsulorhexis could be perfectly centered (**Fig. 4**).

The last step was to choose the modality of nucleus fragmentation (**Fig. 5,6**).

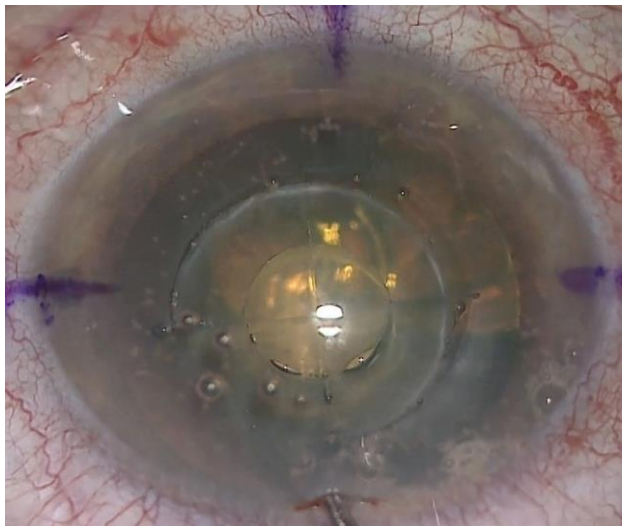

Fig. 5 Hybrid pattern fragmentation

Fig. 6 Cylinder pattern fragmentation

A tri-planar primary corneal incision (2,3mm) was performed for phacoemulsification and intraocular lens implantation and two 90° apart uni-planar (1,3mm) secondary incisions

were performed for lens manipulating instruments. The length of the primary incision was of around 1,7 mm (**Fig. 7**).

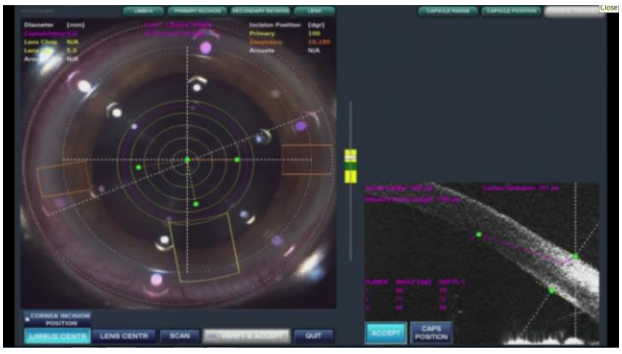

Fig. 7 Incisional architecture

The patient was positioned under the usual operating microscope. After draping the eye, the corneal incisions were opened with a blunt spatula, viscoelastic material was injected in the anterior chamber through one side-port and the anterior capsule was removed with Utrata forceps [**3**].

Phacoemulsification of the nucleus and aspiration of the cortex were performed with the Alcon Centurion Vision System. Monofocal, toric, and multifocal AcrySof IOLs (Alcon Laboratories Inc.) were implanted successfully in the capsular bag with the aid of the AutoSert IOL injector and the viscoelastic material was removed by aspiration. The corneal wounds were sealed, with or without hydration of the edges with BSS. Sutures were used in one case only.

In the end, dexamethasone and gentamicin were injected subconjunctivally for endophthalmitis prevention. No intra- or postoperative complications occurred. Postoperative topical therapy included topical antibiotics and steroidal anti-inflammatory drops for 4-6 weeks.

The surgical parameters evaluated were the capsulorhexis, the corneal incisions and the lens fragmentation.

Results

Fifty eyes of fifty patients (32 women, 64%; 18 men, 36%) were enrolled in the study. The mean age of the patients was 67,74 years, p=0,84 (range: 37-91 years).

A 4,9-4,5 mm diameter was chosen to perform capsulotomy according to the diameter of the dilated pupil. A continuous, central, curvilinear capsulorhexis was performed by using the femtolaser (free-floating capsulotomy) in 48 cases, 96%. In one case with white cataract and in one case with traumatic cataract areas of micro-adhesions were reported. These were detached with the Utrata forceps following the contour of the femtolaser capsulotomy. The effect of circular femtosecond capsulotomies on intraocular lens centration was analyzed one, three and six months after surgery on dilated pupil at the slit-lamp. Femtolaser capsulotomy resulted in a complete and regular 360°- overlap of the anterior capsule over the posterior chamber lens optics in all cases (**Fig. 8**). Horizontal decentration was found in 2 cases, 4% and vertical decentration in one case, 2%.

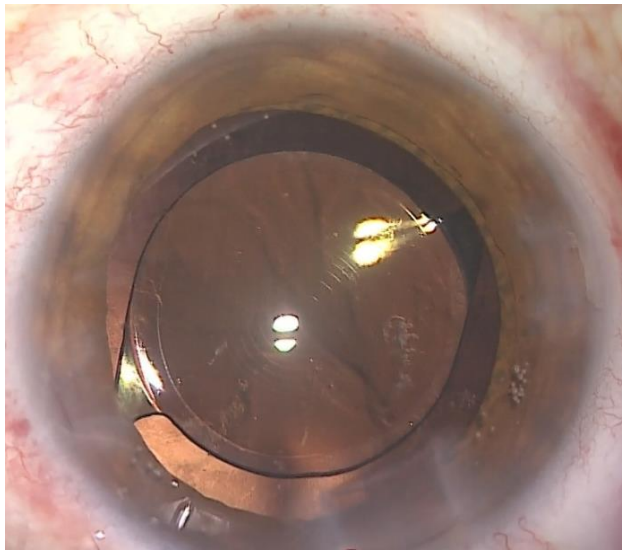

Fig. 8 IOL centration

The primary corneal incision was self-sealing in 49 cases, 98%. The secondary incisions were sometimes difficult to place at the limbus.

The hybrid pattern of photodisruption was used to liquefy the crystalline lens in 42 cases, 84% and the cylindrical pattern in 8 cases, 16%. The hybrid-pattern fragmentation was incomplete in one case of white cataract and in one case of traumatic cataract with a zonular dialysis under 45°.

Difficulties in visualizing the posterior capsule were encountered in one case with very dense vitreous degeneration.

Discussions

The cataract surgery using manual phacoemulsification is one of the most common medical procedures and definitely one of the safest and most effective, but also totally dependent on the surgical skills and experience of the physician. New, advanced technology IOLs are nowadays on the market and patients want surgery at a younger age than ever before with very high expectations regarding the refractive outcome [**4**].

The femtosecond laser-assisted cataract surgery is not substantially different from phacoemulsification only the key steps are more consistent and automated [**5**]. The self-sealing corneal wounds, the more precise and better-centered capsulotomy and the fragmentation of the lens nucleus, all lead to a reduced number of complications [**6**]. The beauty and novelty of the femtolaser technology consists in our ability to customize the pre- and intraoperative parameters, once the proper suction is achieved, which brings us closer to perfection. The femtolaser precision is due to the new real time optical coherence tomography (OCT) software programs allowing us to visualize the anterior segment of the eye during every step of the treatment. Peer-reviewed studies have already demonstrated that the femtolaser capsulotomy is better centered and more precise compared to manual capsulorhexis. Due to an adequate capsulotomy, a more precise postoperative IOL positioning can be achieved. A properly sized and centered capsulorhexis is essential to reach demanding refractive results. A 360° overlapping capsular edge was thought to be an important feature for standardizing refractive results, preventing optic decentration, shifts toward myopia or hyperopia, tilt or capsular opacification due to symmetric contractile forces of the capsular bag [**7**]. An irregular or eccentric capsulotomy would lose all these advantages.

With femtolaser technology, the corneal wounds can be created with the desired size, geometry and location. The corneal incisions are self-sealing, preventing wound leakage, maintaining a stable anterior chamber and avoiding postoperative vision-threatening endophthalmitis. The peripheral localization is very important to avoid surgically induced astigmatism (SIA) [**7**], but it is more difficult to achieve this during the learning curve.

The nucleus is pre chopped during laser-assisted cataract surgery and effective phaco time is optimized. A four-segment pre chop approach is preferred. This allows burying the phaco tip inside the nucleus for a quick and easy separation and emulsification. Another benefit of pre chopping the lens is that it reduces the stress placed on the zonules. This is particularly important in eyes with traumatic cataract, as the zonules are already weak. In our study, we had one case of traumatic cataract with zonular dialysis under 45° in which the femtolaser proved its efficiency.

Conclusions

1. The main advantages of femtosecond laser-assisted cataract surgery are standardized corneal incisions, perfectly centered and round capsulorhexis, lens nucleus fragmentation even in eyes with hard cataracts.
2. The femtolaser precision is due to the new real time optical coherence tomography software program, which covers the whole anterior segment, up to the posterior capsule of the crystalline lens.
3. It is helpful for less experienced surgeons since it requires a short learning curve and the uniformity of its results is beneficial for the patient.
4. The disadvantages of using femtolaser technology are its high cost and the still insufficient peer-reviewed data.

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