



Case report

Femtosecond laser-assisted cataract surgery and implantable miniature telescope

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ABSTRACT

Purpose: This paper is a case report of the use of femtosecond laser for cataract surgery to implant an implantable miniature telescope for a patient with large central areas of geographic atrophy.**Observations:** On postoperative day 1 the patient's uncorrected visual acuity at near was 20/50. The cornea was clear and the patient reported no problem with navigation without occupational therapy training.**Conclusions and importance:** To our knowledge and confirmed by the manufacturer of the implantable miniature telescope this is the first case ever reported of a patient who has undergone femtosecond laser cataract surgery with corneal astigmatism correction and implantation of the implantable miniature telescope. This is also the first case report of the preoperative use of microperimetry and visual electrophysiology to evaluate a patient's postoperative potential visual acuity. The success of the procedure illustrated the importance of meticulous preoperative planning, the combined use of state-of-the-art technologies and the seamless teamwork in order to achieve the best clinical outcome for patients who undergo implantation of the implantable miniature telescope.© 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Many phenotypic variants of age-related macular degeneration (AMD) exist including those with focal centralized atrophy. Geographic atrophy is one phenotypic variant of dry AMD. Bilateral geographic scarring or atrophy is considered to be untreatable and visual rehabilitation is dependent on low vision aids. Currently there is no medical treatment for this entity. The implantable miniature telescope is the only surgical option for these patients.¹ Successful implantation of the implantable miniature telescope requires the preservation of corneal health, particularly the preservation of endothelial cells and the presence of an intact capsule for placement of the implantable miniature telescope (IMT). This requirement can be achieved with the use of femtosecond laser assisted cataract surgery (FLACS). The laser significantly decreases the effective phacoemulsification time, which may help lower postoperative complications.² The laser also allows the

preservation of both the anterior and posterior capsules² to allow the safe placement of the telescope.

2. Case report

The patient is a 65-year-old Vietnamese man with a diagnosis of bilateral focal geographic AMD (Figs. 1–6.)

Preoperatively the patient was evaluated with history and physical examination, slit lamp examination (Haag Streit, Mason, OH, USA), autorefractometry and manifest refraction (Topcon, Livermore, CA, USA), digital tonometry (Ziemer, Alton, IL, USA), fundus photography (Centervue, Padova, Italy), Centrasight simulator test (Visioncare, Saratoga, CA, USA), ultrasound immersion (Quantel Medical, Bozeman, MT, USA), and optical biometrics (Zeiss, Dublin, CA, USA), cornea and lens aberrometry/topography (Tracey Technologies, Houston, TX, USA), endothelial cell count (Konan, Irvine, CA, USA), optical coherent tomography (OCT) (Zeiss, Dublin, CA, USA), fluorescein angiography and widefield fundus imaging (Optos, Marlborough, MA, USA), macular integrity assessment (MAIA) (Centervue, Padova, Italy), pattern electroretinography (PERG) and visual evoked potential measurement (VEP) (Diopsys,

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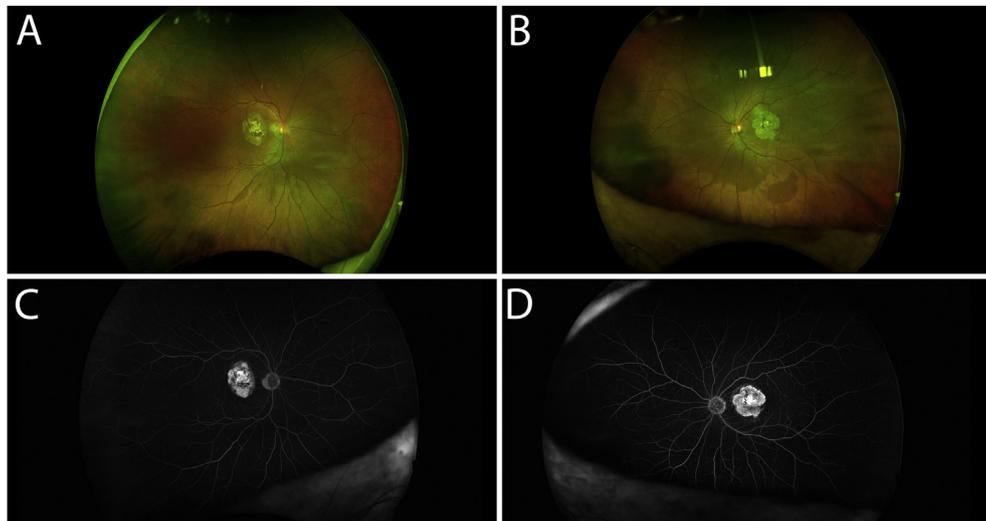


Fig. 1. A, Preoperative fundus photography of right eye; B, Preoperative fundus photography of left eye; C, Preoperative fluorescein angiogram of right eye; D, Preoperative fluorescein angiogram of left eye.

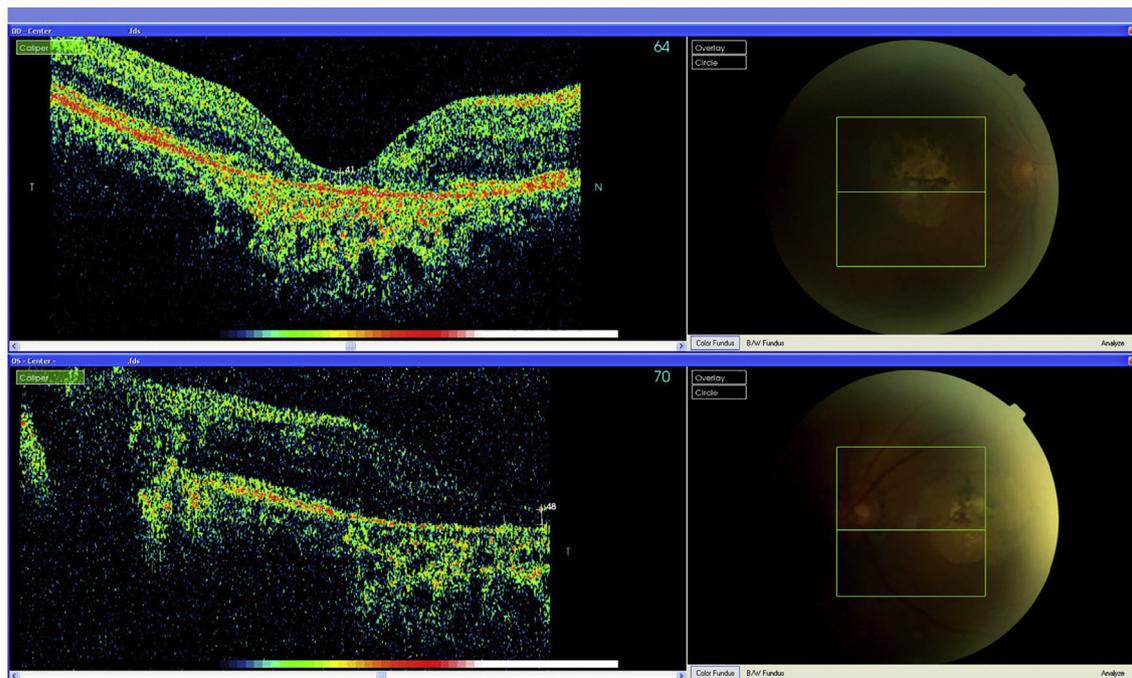


Fig. 2. Preoperative optical coherent tomography.

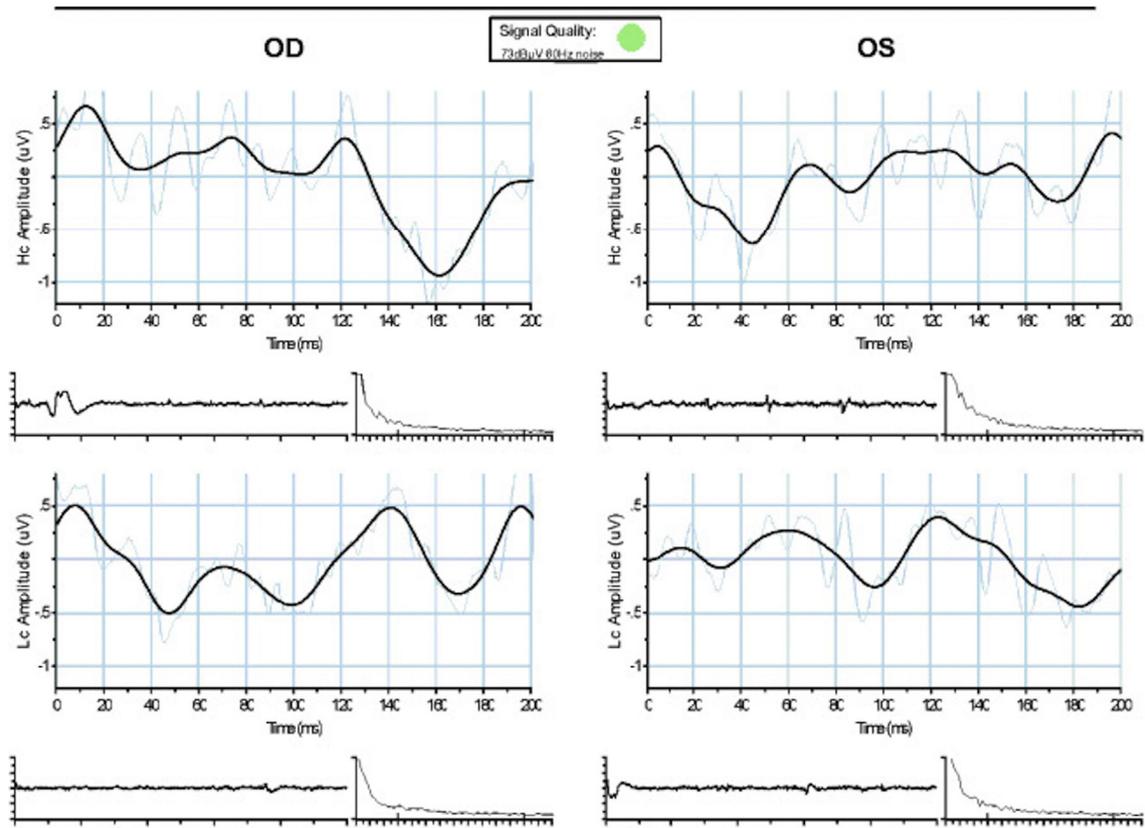
Pine Brook, NJ, USA) and pupil measurement (Oasis, San Dimas, CA, USA).

The patient's uncorrected visual acuity preoperative was 20/200 in either eye. The patient best-corrected preoperative visual acuity was 20/80 in either eye at 1.6 M at near. When corrected with the Centrasight external simulator with astigmatism refraction the patient saw 20/30 with either eye.

The patient was noted to have medial and lateral pterygia of less than 1 mm on each side of the limbus in both eyes. The patient was also noted to have a lower lid length of 33 mm. The left eye was chosen for placement of the IMT because the patient preferred to

use the left eye for near tasks. Preoperative corneal topography of the left eye showed regular astigmatism of 0.77 D at axis 140 (Fig. 10).

Fundus examination showed central atrophic scars of the macula affecting the fovea of both eyes. IVFA showed large central RPE window defects with no leakage consistent with atrophic RPE noted on fundus examination. OCT confirmed severe damage to the fovea of both eyes. PERG showed bilateral widespread photoreceptor and inner retinal damage. MP showed substantial loss of central fields corresponding to the patient's central defects. It also showed surprisingly normal functional retina outside the scarred

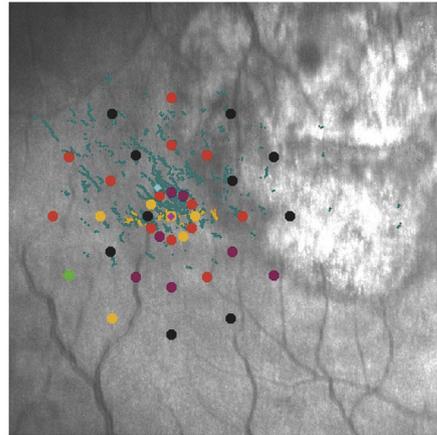
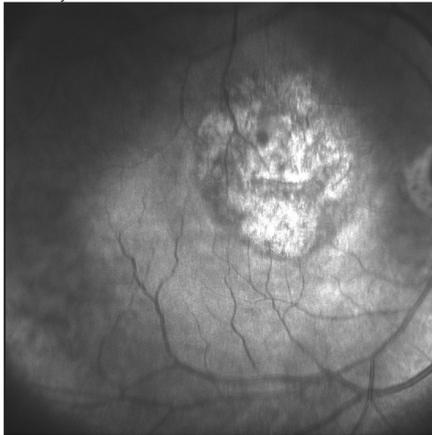


Parameter	OD Hc	OD Lc	OS Hc	OS Lc
Magnitude (uV)	0.65	0.62	0.87	0.62
MagnitudeD	0.25	0.39	0.24	0.18
MagD/Mag Ratio	0.39	0.63	0.27	0.29
SNR (dB)	1.1	0.3	0.5	0.0
Artifacts	1	0	0	0

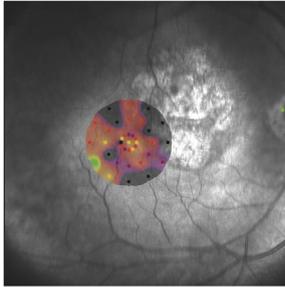
Fig. 3. Preoperative electroretinography.

Expert exam # [4-Levels-Fixed strategy] /
Reliability Index: 100%

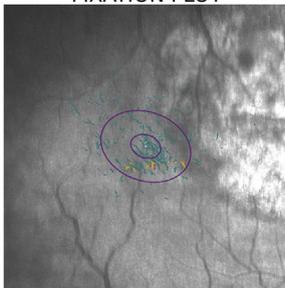
/ Duration: 3' 20"



SENSITIVITY MAP

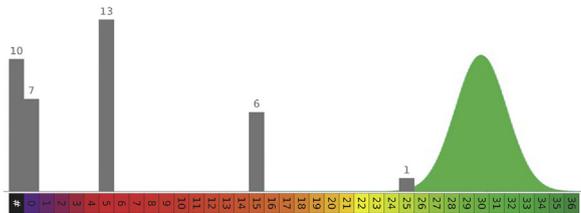


FIXATION PLOT



Bivariate Contour Ellipse Area:
63% BCEA: 2.0° x 1.5°, Area = 9.0°², angle = -19.8°
95% BCEA: 5.9° x 4.4°, Area = 81.1°², angle = -19.8°

Histogram of Threshold Frequencies



P1=27%, P2=63%

Fixation Stability: STABLE (green), REL. UNSTABLE (yellow), UNSTABLE (red)

Fixation Graph

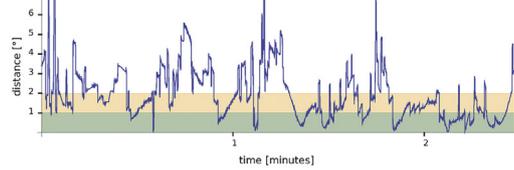


Fig. 4. Preoperative microperimetry of right eye.

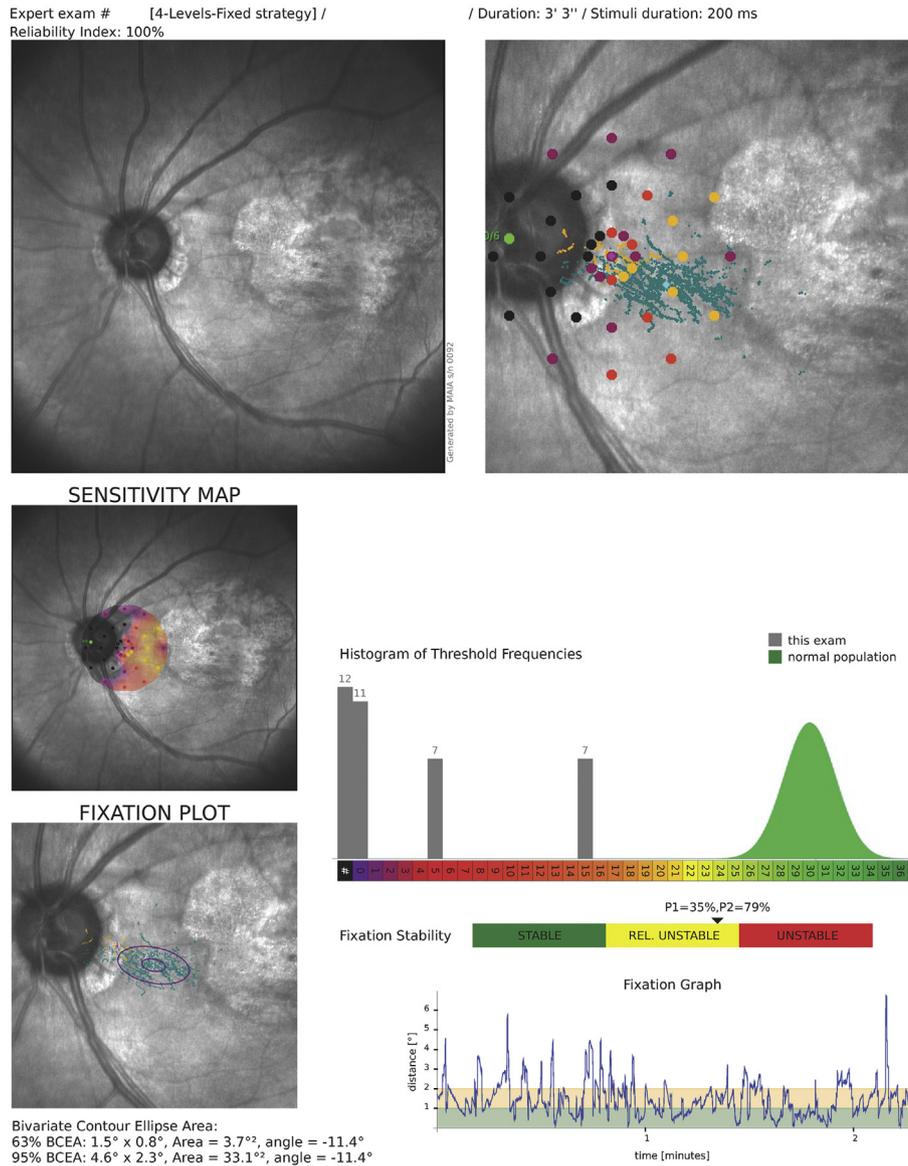
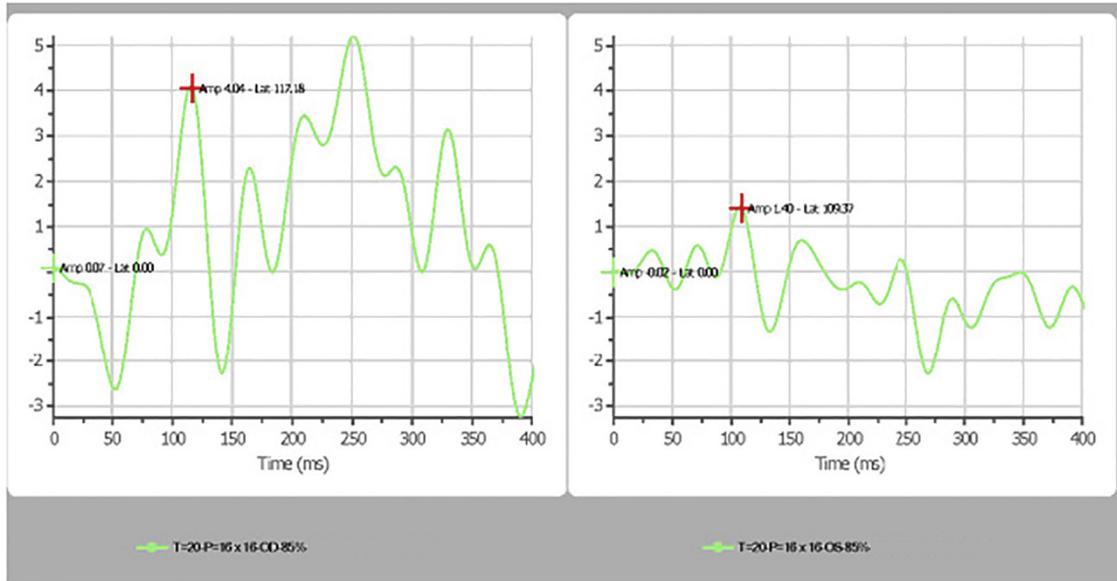


Fig. 5. Preoperative microperimetry of left eye.



	T=20-P=16 x 16-OD-85%-C-	T=20-P=16 x 16-OS-35%-C-
Left Cursor Lat	0.0 ms	0.0 ms
Amp	0.07 uV	-0.02 uV
Right Cursor Lat	117.2 ms	109.4 ms
Amp	4.04 uV	1.40 uV
Delta Lat	117.2 ms	109.4 ms
Amp	3.96 uV	1.42 uV
Artifacts	0	0
Eye	OD	OS
Test Duration	20 sec	20 sec
Contrast	85%	85%
Pattern	Checkerboard	Checkerboard
CheckSize	16 x 16	16 x 16
Correction	N	N
SWVersion	2.19.5921	2.19.5921
Filtered	Y	Y
Sensor Value	87	100
Sensor Threshold	130	130
Waveform	VEP	VEP
Extractor	Y	Y
Operator Name		
Signal Index	74%	50%
BCVA	20/100	20/100
S/C/Ax/Ad	///	///

Fig. 6. Preoperative visual evoked potential.

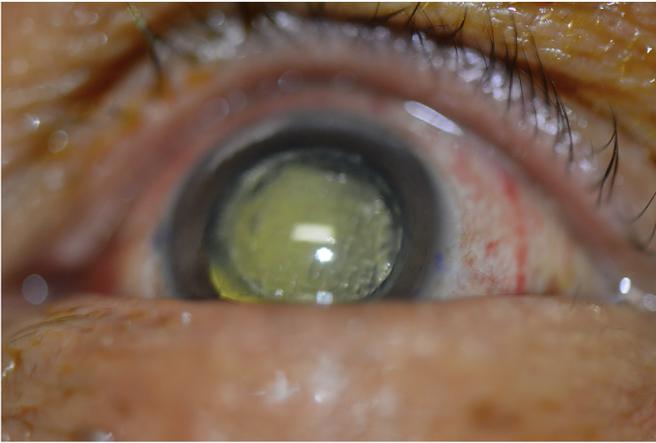


Fig. 7. Immediate post femtosecond laser assisted cataract surgery. Note the complete capsulorhexis.



Fig. 8. Immediate post implantation of the implantable miniature telescope.

areas. VEP showed normal latency consistent with healthy optic nerves.

The patient underwent femtosecond laser cataract surgery and limbal relaxing incisions using the femtosecond laser with implantation of the implantable miniature telescope.

The laser procedure using the Catalys laser system (Abott Medical Optics, Milpitas, CA, USA) was carried out successfully using the 14 mm diameter eyepiece (suction ring). There was no loss of suction throughout the procedure. Refractive surgery was coupled with the lens fragmentation procedure. The patient underwent astigmatism correction with laser limbal relaxation incision; the arc length was 40°, the axis was 140 and the arcuate cut was delivered at 9 mm from the pupillary center. The primary incision was done manually and incorporated into the corneal incision to achieve the 13 mm wound needed for implantation of the IMT. Preoperative post-dilation pupillometry showed a pupil size of 8 mm. The capsulorhexis by FLACS was set for maximum size. FLACS was programmed to achieve a maximum capsulorhexis

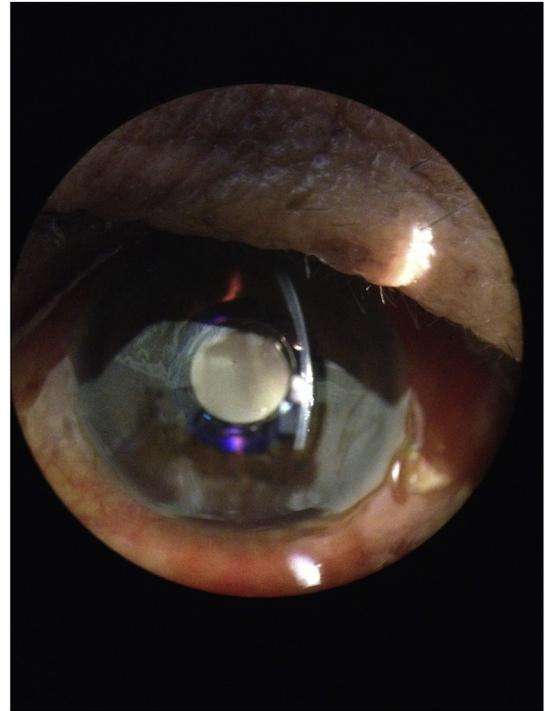


Fig. 9. Implantable miniature telescope on postoperative day 2.

size of 1 mm less than the largest dilated pupil size, which was, in this case, 8 mm. It is interesting to note that the femtosecond laser registered a pupil of 7.3 mm and displayed a maximized capsulorhexis of 6.3 mm. The capsulorhexis was completed with no missed or uncut portion (Fig. 7). The posterior capsule was intact and a clear cornea was maintained at the conclusion of the procedure (Fig. 8). Because of the large areas of normal functional retina available positioning the IMT (Visioncare, Saratoga, CA, USA) to project a magnified image on areas of the healthy retina outside the central atrophic area was performed with ease. The corneal scleral wound was closed with absorbable interrupted sutures (9-0 vicryl).

The cornea was clear of edema on postoperative days 1, 2, 12 and 93. The patient's uncorrected visual acuity for reading was 20/50 at near and the patient was able to navigate without assistance on postoperative days 1, 2, 12 and 93.

On postoperative day 2 uncorrected visual acuity was 20/50 + 1. The implant was noted to be centered with respect to the pupillary axis (Fig. 9). Intraocular pressure was 14 on postoperative day 2. The corneal topography showed regular astigmatism of 1.04 D at axis 36 on postoperative day 2 (Fig. 11) and of 0.48 D at axis 180 on postoperative day 12 (Fig. 12).

3. Discussion

This case illustrates the major steps that are needed to achieve successful implantation of the IMT using FLACS. Because the patient had irregular ocular surface (presence of pterygia), suction loss could occur during FLACS. The lower lid length was measured to be 33 mm, which met the minimal lid length 32 mm criterion that would allow the 14 mm diameter suction ring to fit on the operated eye. As noted in a previous study, the patient's lower lid length was above the minimum lower lid length of 32 mm that was needed to fit the 14 mm suction ring,³ and therefore suction loss was prevented during FLACS.

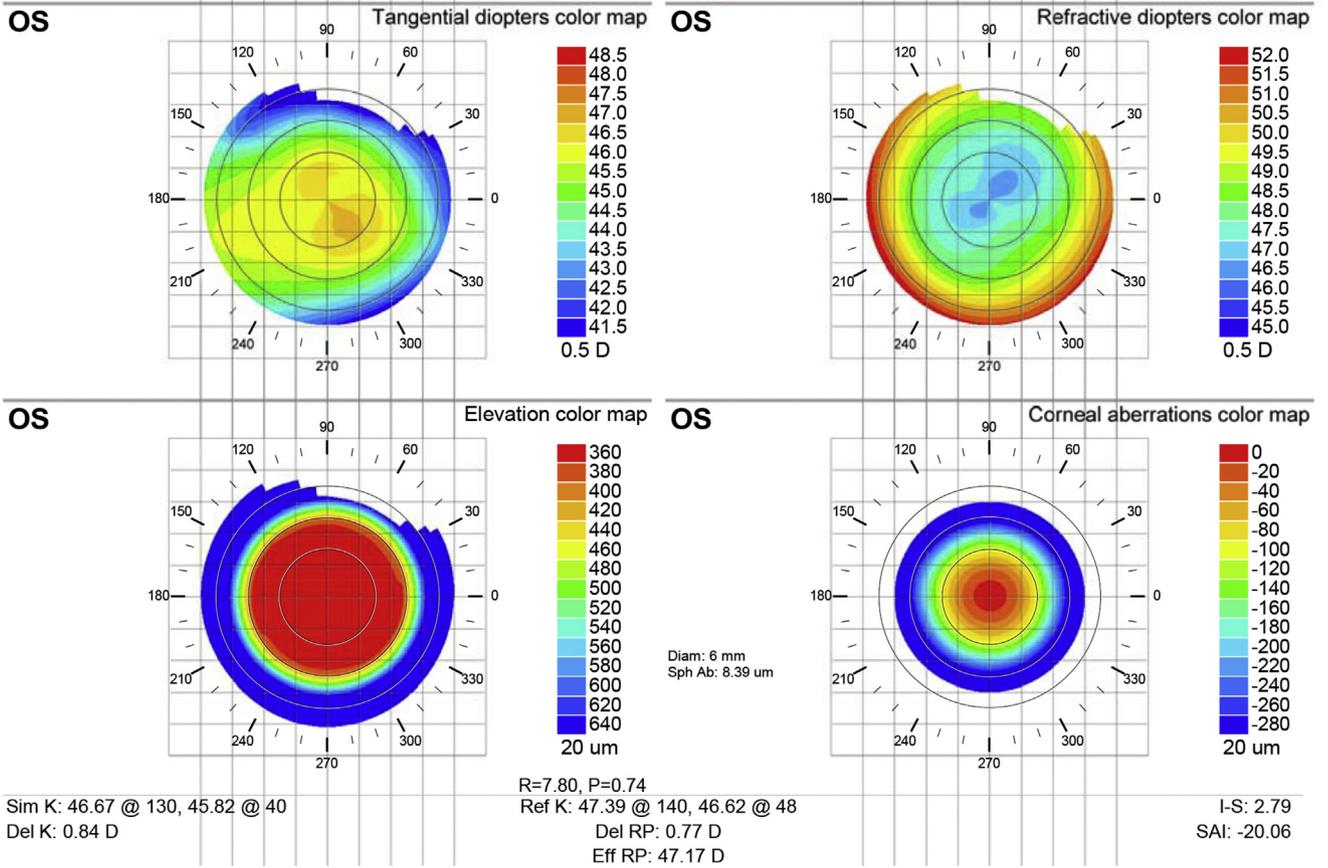


Fig. 10. Preoperative corneal topography.

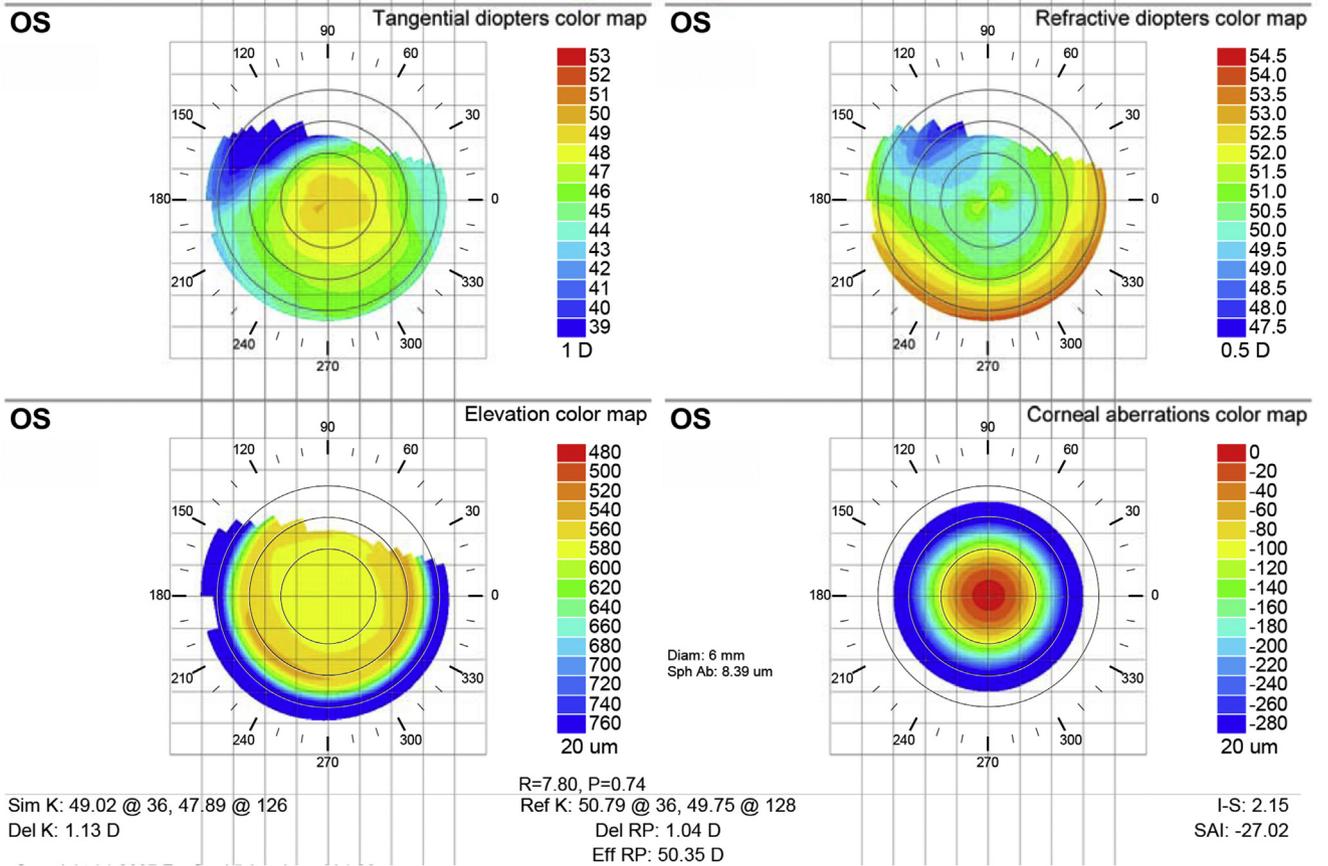


Fig. 11. Postoperative day 2 corneal topography.

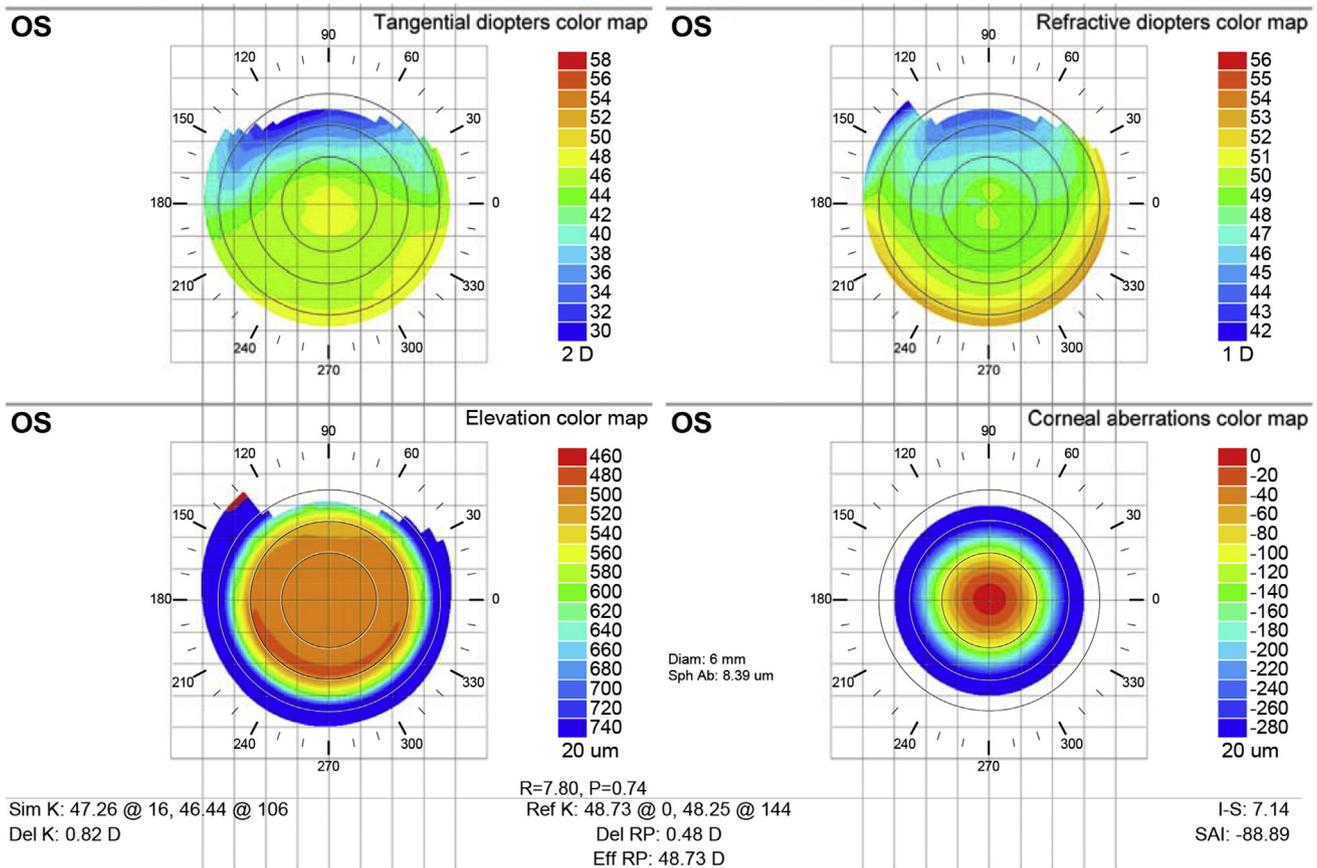


Fig. 12. Postoperative day 12 corneal topography.

The corneal astigmatism correction with the femtosecond laser and the use of absorbable sutures allowed the cornea to only retain less than half of a diopter of astigmatism at axis 180 on postoperative day 12. With the accumulation of data from future cases a nomogram can be created to predict the amount of astigmatism induced by the large corneal scleral wound and femtosecond laser can be used to correct corneal astigmatism even before the corneal scleral wound is made. We found that the use of absorbable sutures helped achieve a neutral effect with respect to surgically induced astigmatism.

The use of microperimetry, ERG and VEP helped localize the defect and predict visual benefit based on the presence of healthy peripheral retina and optic nerves. Identification of healthy retina allowed the anterior segment surgeon to position the IMT perfectly to achieve optimal visual outcome. Our effort represented the first successful attempt to couple a magnifying device with healthy retinal areas. FLACS allowed the accurate placement of the capsulorhexis, which in turn helped direct the IMT to target areas of functioning retina, or in case of total blindness, areas of alternative sensory devices including retinal prostheses such as artificial retina silicon microchips or nanotechnology silicon wafers.

4. Conclusions

This report is the first known in the English-language literature of an implantation of the IMT using FLACS. This case illustrates that with careful preoperative planning and combined use of state-of-the-art technologies such as FLACS, computerized automated microperimetry MAIA, ability to capture wide fields of retina, and

highly reliable devices for electrophysiologic assessment of nerve and retina, optimal clinical outcomes can be achieved for patients who undergo implantation of the IMT.

Patient consent

Written consent to publish personal information and case details has been obtained from the patient.

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Authorship

All authors attest that they meet the current ICMJE criteria for authorship.

Conflicts of interest

The authors have no financial disclosure.

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None.

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