

Is Lasik an Effective Treatment Modality for Hyperopia or Hyperopic Astigmatism?

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ABSTRACT

Purpose: To assess the efficacy, safety and stability of LASIK surgery for treatment of low to moderate degree hyperopia and hyperopic astigmatism.

Patients and methods: The study included 34 eyes in 17 patients (7 males, and 10 females) with bilateral low to moderate degree hyperopia or hyperopic astigmatism. Their mean age \pm SD was 26.7 ± 4.1 years. Range of hyperopia was between +1.75 to +5.50 D, astigmatic errors range was 0.00 to -1.50 D while the spherical equivalent refraction ranged from +1.4 to + 4.8 D. Patients included in this study had a stable refraction for at least one year. All patients underwent bilateral LASIK surgery in the same session in Dr Soliman Faqeeh Hospital (DSFH) and the Eye Subspecialty Center (ESC) using the ALLEGRETTO EYE - Q Excimer Laser machine.

Results: UCVA after one year was 20/20 or better in 30 eyes (88.2%), 20/30 or better in 32 eyes (94.1%) and 20/40 or better in 34 eyes (100%), while BCVA was 20/20 or better in 33 eyes (97.1%) and 20/40 or better in 34 eyes (100%). There was no decrease in UCVA after LASIK surgery. One eye (2.9%) showed 2 lines drop in BCVA after LASIK surgery due to broad wrinkles of the flap. The flap was lifted after one day; trial to flatten the wrinkles showed incomplete resolution. One eye (2.9%) showed diffuse lamellar keratitis (DLK) at one week after LASIK surgery. There was regression in the manifest spherical equivalent refraction one year after LASIK surgery as compared with that at one month, but the difference was statistically insignificant ($P=0.46$). The mean score of patient satisfaction was 9.4 at one year postoperatively.

Conclusion: LASIK surgery is a safe, predictable, stable and effective for treatment of mild to moderate degree hyperopia and hyperopic astigmatism. No significant regression in UCVA, BCVA or manifest refraction was reported up to 12 months follow up.

Key words: LASIK, Ablation, Hyperopia, Astigmatism, Pentacam.

INTRODUCTION

Laser in situ keratomileusis (LASIK) is a surgical procedure for the treatment of myopia, myopic and hyperopic astigmatism, and low to moderate hyperopia.⁽¹⁾

Correction of hyperopia is significantly more difficult to be predicted than myopia. Hyperopic correction is significantly more likely to regress at a greater percentage than myopic correction⁽²⁻³⁾.

Photorefractive keratectomy (PRK) has been used successfully for treatment of hyperopia but has problems of regression, induced astigmatism, and corneal haze. LASIK overcomes some disadvantages of PRK and has become the procedure of choice for treating hyperopia.⁽⁴⁾ *Sheri* reported that the

upper limit for hyperopic LASIK correction is +5.0D⁽⁵⁾, while *Waring et al.* reported that the upper limit for hyperopic LASIK correction is +6.0D.⁽⁶⁾

LASIK is approved by the FDA (US Food and Drug Administration) for the treatment of hyperopia.⁽⁷⁾

Hyperopic LASIK consists of an annular zone of ablation to cause a relative flattening of the corneal periphery and a concomitant relative steepening of the center (optical zone) to achieve the desired refractive effect.⁽⁸⁾

AIM OF THE STUDY

The aim of this study is to assess the efficacy, safety and stability of LASIK surgery for treatment of low to moderate degree hyperopia and hyperopic astigmatism.

PATIENTS AND METHODS:

This study was held at Dr Soliman Faqeeh Hospital (DSFH) and the Eye Subspecialty Center (ESC) between February, 2007 and April, 2014. It included 34 eyes in 17 patients, 7 males, (41.2%), and 10 females, (58.8%) with bilateral mild to moderate degree hyperopia or hyperopic astigmatism. Their mean age was 26.7 ± 4.1 years (ranged from 20 to 36 years).

In this study we aim to correct the manifest hyperopia that ranged from +1.75 to +5.50 diopters (mean \pm SD was $+3.4 \pm 1.2$ D). Range of astigmatic errors was 0.00 to -1.50 D (mean \pm SD was -0.6 ± 0.3 D). Range of spherical equivalent was +1.30 to +4.8 D (mean \pm SD was $+3.1 \pm 1.1$ D).

Inclusion criteria included:

- Age is above 20 years.
- Mild to moderate degree of hyperopia or hyperopic astigmatism.
- Stable refraction for at least one year duration prior to LASIK surgery.
- Normal corneal topography.
- Calculated post LASIK residual stromal thickness more than 300 microns.

Exclusion criteria include:

- Corneal diseases and patients who had abnormal corneal topography.
- Calculated post LASIK residual stromal thickness less than 300 microns.
- Dry eye.
- Glaucoma.
- Cataract.
- Active ocular diseases.
- Retinal diseases.
- Systemic diseases that could interfere with wound healing as uncontrolled diabetes and connective tissue disorders.

Contact lens wearers were instructed to discontinue contact lens use for at least 10 days prior to pre-LASIK investigations.

Patients were subjected to the following:

- Testing the Uncorrected Visual Acuity (UCVA) and best Corrected Visual Acuity (BCVA).
- Autorefractometry, cycloplegic refraction (using 1% cyclopentolate eye drops) and lens trial test that gives the BCVA.
- Slit lamp examination.

- Applanation tonometry.
- Fundus examination.
- Pentacam examination.

Advantages and possible complications were explained to the patient prior to LASIK surgery, and an informed consent was signed. Emmetropia was the target of treatment in all eyes. Allegretto nomogram adjustments were used for calculation of treatment parameters.

All patients underwent bilateral LASIK in the same session using the ALLEGRETTO EYE - Q Excimer Laser machine.

Eyes undergoing surgery were prepared by cleaning of the periocular area using providone - iodine and a plastic drape.

Topical anesthesia was applied to the conjunctival sac using 0.4% benoxinate hydrochloride, and a wire lid speculum was inserted to expose the globe.

MORIA 2 microkeratome was used in all cases to create lamellar hinged superior flaps of 9.5 mm. Laser was focused on the cornea and centered on the pupil with the activated eye tracker.

The flap was lifted and the ablation was aimed at the dry stromal bed in a 6.5 mm treatment zone. The flap was then repositioned and the interface was irrigated with balanced saline solution (BSS), and the cornea was then dried.

Slit lamp examination was performed immediately postoperatively for each case to confirm proper flap reposition and to exclude flap wrinkles. Tobramycin and Dexamethasone eye drops were then applied, and the patient was instructed to use them 4 times / day for 7 days. Dextrans with hydroxypropyl methyl cellulose eye drops were prescribed 4 times / day for one month. Avoiding eye friction after Lasik was instructed.

Post LASIK follow up was done after one day, one week, one month, 6 months, and 12 months after surgery. During the follow up visit, patients were examined for UCVA, BCVA, and slit lamp examination. Cycloplegic refraction and corneal topography were repeated after one month and one year.

Score for patient satisfaction was graded according to the following items:

- Visual Acuity
- Clarity of Vision
- Symptoms of Dry eye
- Night hallows and glare

Table (1) shows the criteria of grades of post-LASIK patient satisfaction.

RESULTS:

Thirty four eyes of 17 patients included in this study underwent LASIK for correction of mild to moderate degree manifest hyperopia and hyperopic astigmatism.

Uncorrected visual acuity (UCVA) at one week postoperatively was 20/20 or better in 25 eyes (73.5%), 20/30 or better in 31 eyes (91.2%) and 20/40 or better in 34 eyes (100%). Best corrected visual acuity (BCVA) at one week was 20/20 or better in 32 eyes (94.1%), 20/30 or better in 32 eyes (94.1%) and 20/40 or better in 34 eyes (100%).

One month, and 6 months postoperatively, UCVA was 20/20 or better in 29 eyes (85.3%), 20/30 or better in 32 eyes (94.1%) and 20/40 or better in 34 eyes (100%). BCVA was 20/20 or better in 33 eyes (97.1%), 20/30 or better in 33 eyes (97.1%) and 20/40 or better in 34 eyes (100%).

UCVA at one year was 20/20 or better in 30 eyes (88.2%), 20/25 or better in 32 eyes (94.1%) and 20/40 or better in 34 eyes (100%). There was no decrease in UCVA after LASIK. BCVA at one year was 20/20 or better in 33 eyes (97.1%), 20/30 or better in 33 eyes (97.1%) and 20/40 or better in 34 eyes (100%).

Mean post LASIK manifest spherical refraction \pm SD after one month was $+0.62 \pm 0.33$ diopters (range: -0.75 to + 1.50 diopters). After one year it was $+0.75 \pm 0.40$ diopters (range: - 0.50 to + 1.75 diopters).

Mean post LASIK cylindrical error \pm SD at one month was -0.24 ± 0.16 diopters (range: 0 to -1.00 diopter), while it was -0.22 ± 0.15 diopters at one year after LASIK (range: 0 to - 0.75 diopters).

Mean post LASIK spherical equivalent refraction \pm SD at one month was $+0.53 \pm 0.28$ diopters (range: -0.82 to +1.20 diopters), while it was $+0.62 \pm 0.31$ diopters at one year after LASIK (range: -0.58 to +1.44 diopters).

Twenty seven eyes (79.4%) showed manifest spherical equivalent refraction within ± 0.50 D, while 30 eyes (88.2%) were within ± 1.00 D of emmetropia. There was statistically insignificant difference between manifest spherical equivalent refraction at one month and one year after LASIK ($P=0.46$).

No intra-operative complications were reported.

At the end of follow up period (12 months) corneal transparency was not affected in any of our cases.

Postoperative complications included:

a) Wrinkles of corneal flap which was discovered at one week follow up in one eye (2.9%). History of eye friction was positive. Trial to flatten the wrinkles under surface anesthesia showed incomplete resolution.

b) Diffuse Lamellar Keratitis (DLK), which was also discovered at one week follow up in one eye (2.9%). Complete resolution was observed after one month by the frequent use of local prednisolone acetate (every 2 hours for 7 days, then 4 times daily for 7 days) and systemic steroids (prednisolone acetate, 5 mg tablets, 4 tablets daily for 7 days. They were withdrawn by 5 mg every 5 days).

c) Dry eye symptoms in the form of burning and foreign body sensation were reported in 24 eyes (70.6%) at 7 days, in 8 eyes (23.5%) at one month, in 2 eyes (5.9 %) at 6 months, and also in 2 eyes (5.9%) at one year after LASIK.

Pentacam examination after hyperopic Lasik correction showed central steeping in the axial curvature front in all cases (100%) (Fig 1,2 & 7,8).

Corneal thickness was not affected centrally but decreased markedly at the paracentral area in all cases (the ablation zone) (Fig 3,4 & 9,10).

Elevation front showed marked drop in keratometric power at the ablation zone associated with increased keratometric power in the central cornea matched with the corrected hyperopia (Fig 5,6 & 11,12).

Regression of hyperopic correction was reported one year after LASIK (table 2), but was statistically insignificant ($p=0.46$).

The mean score of patient satisfaction was:

✓ At one week : 8.4

- ✓ At one month : 9.3
- ✓ At one 6 months : 9.5
- ✓ At one year : 9.4

DISCUSSION

Over the past decade, LASIK has become the favored surgical treatment for low to moderate hyperopia and hyperopic astigmatism.⁽⁹⁾

There are several advantages of LASIK surgery, including a short healing time, high success rate, and the ability to correct a wider range of refractive errors than other types of surgery. Compared to PRK ; because there is no flap to cover the cornea while it heals, the healing time with PRK is longer, but it is a good option for those who may not be candidates for LASIK due to thin corneas.⁽¹⁰⁾

Compared to past surgical techniques such as laser thermokeratoplasty (LTK), hyperopic automated lamellar keratoplasty (ALK), and hexagonal keratotomy, LASIK has proven to be significantly safer, can treat a larger amount of hyperopia, can treat astigmatism more predictably, and has more long stability.⁽¹¹⁻¹⁵⁾

Sheri reported that large ablation diameter and the difficulty to deliver uniformly distributed laser energy in ablation zones larger than 6 mm may lead to less predictability of LASIK for treatment of hyperopia.⁽⁵⁾

O'Brart reported that new models of microkeratomes permit the formation of larger corneal flaps. Also new models of excimer laser machines provide uniformly distributed laser energy in treatment of hyperopia.⁽¹⁶⁾

Histopathological evidence has demonstrated a more favorable response after irradiation with 213 nm wave length which may provide a more predictable wound healing and refractive response.⁽⁸⁾

El Helw and Emara reported that the more the optical zone during hyperopic LASIK treatment, the more the predictability and stability of refraction. They treated right eyes of 4 patients with hyperopia more than 4.0 D by LASIK using 6.5 mm optical zone diameter (group 1), left eyes of these patients were treated using optical zone diameter 6.0 mm (group 2). Median post operative UCVA

in group 1 was 0.17 and BCVA was 0.15. In group 2 Median postoperative UCVA was 0.3 and BCVA was 0.15. Group 1 eyes were stabilizing after the three months period in contrast with group 2 in which the refractive changes continued throughout the follow up period (6 months).⁽¹⁷⁾

Davidort et al. reported that hyperopic LASIK is safe and effective using different ablation zone diameters. They also reported that there is increasing tendency toward over correction with progressively large optical zone diameters.⁽¹⁸⁾

In this study we aim to correct the manifest hyperopia that ranged from +1.75 to +5.50 diopters (mean \pm SD was $+3.4 \pm 1.2$ D). Range of astigmatic errors was 0.00 to -1.50 D (mean \pm SD was -0.6 ± 0.3 D). Range of spherical equivalent was +1.30 to +4.8 D (mean \pm SD was $+3.1 \pm 1.1$ D). We used 6.5 mm treatment zone, that was reported to be safe, improving visual outcomes, with more predictability, facilitates centration of the ablation over the entrance pupil and decreases centration difficulties in the hyperopic eyes.^(19,20)

At one year we achieved UCVA of 20/20 of 94.1% and 20/40 or better for all eyes (100%) in agreement with Seward and his associates⁽¹⁶⁾. *Waring et al.* reported that they achieved UCVA 20/40 or better in 99% after hyperopic correction at 6 months postoperatively.⁽⁹⁾

The mean refraction one year after hyperopic LASIK correction was $+ 0.75 \pm 0.40$ D compared with ± 0.50 D of others (6,11). It was $+ 0.62 \pm 0.31$ D for hyperopia with astigmatism that coincides with ± 0.50 D of *Varely et al.*⁽¹⁾. There was statistically insignificant difference between manifest spherical equivalent refraction at one month and one year after LASIK (P=0.46).

Quito et al. reported a prospective non comparative study which included 34 eyes of 17 patients who underwent hyperopic LASIK and were followed for a mean of 25.18 month. At the end of follow up, 26.47 % had UCVA of 20/20 and 49.12% had UCVA of more than 20/40. Manifest spherical equivalent refraction was within ± 0.50 D of the target refraction in 55.88% and within ± 1.0 D in

85.30% of the study eyes. Refractive stability was noted in the first postoperative month. Hyperopic regression was noted after the third post operative year. No eye lost more than 2 lines of visual acuity. The mean attempted hyperopic correction was + 3.22D and the mean achieved hyperopic correction was +3.10D. Hyperopic regression of 0.3D was observed between the third and fourth post operative year with an average of 0.025D per month.⁽⁸⁾

Waring et al. reported refractive stability for 6 month followed by gradual regression for 3 years post operatively.⁽⁹⁾

Quito et al. reported that the predictability of high hyperopic refractive errors compared with myopic refractive errors of similar degree is much poorer.⁽⁸⁾

It was determined that the use of larger optical and treatment zone offers good predictability and refractive stability for higher degrees of hyperopia by diminishing under correction and regression associated with smaller effective optical zone⁽¹⁹⁾.

In all of our cases, corneal topography after hyperopic LASIK correction showed central steeping, which is not progressive and is not a post-Lasik keratectasia. It is secondary to peripheral ablation in hyperopia.

In our study, regression of hyperopic correction was statistically insignificant after one year follow up ($p=0.46$). To achieve a relative stability after hyperopic LASIK surgery we recommend doing Lasik surgery when absolute hyperopia is nearly equal to the manifest one. Differences in rates of regression in different publications are partly due to differences in inclusion criteria that followed by different investigators. So we believe that strict selection of patients who show close values between absolute and manifest hyperopias will decrease the observed post operative apparent regression rate.

In our study, the mean score for patient satisfaction was 8.4 at one week, 9.3 at one month, 9.5 at one 6 months and 9.4 at one year. Patient satisfaction after hyperopic correction is usually less than after myopic correction. This finding is mostly due to the

loss of the spectacle magnification after hyperopic Lasik correction.

As regards complications, one eye (2.9%) showed broad wrinkles of the flap that was discovered on follow up at one week. It was lifted and the trial to flatten the wrinkles showed incomplete resolution.

One eye (2.9%) showed diffuse lamellar Keratitis (DLK) at one week after LASIK, while others⁽⁶⁾ did not report any complications except for the transient appearance of interface – the irregular, peu-d-orange, slightly shiny, haziness that lasted approximately 6 months, disappeared spontaneously, and did not affect visual function.

In spite of eye lubricants used post operatively; dry eye symptoms were reported in 41.2% at 7 days, in 11.8% at one month, in 5.9% at 3 months, and in 5.9% at one year after LASIK.⁽²¹⁾

CONCLUSION

LASIK is a safe, predictable, stable and effective for treatment of mild to moderate degree hyperopia and hyperopic astigmatism. No significant regression in UCVA, BCVA or manifest refraction was reported up to one year follow up. Patient satisfaction after LASIK correction of hyperopia and hyperopic astigmatism is not enough to encourage patients for this procedure.

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(Table 1) Criteria of post LASIK patient satisfaction

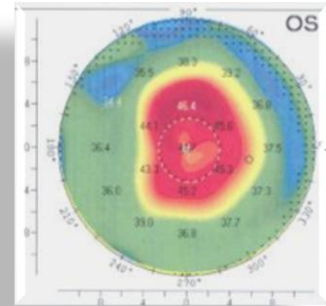
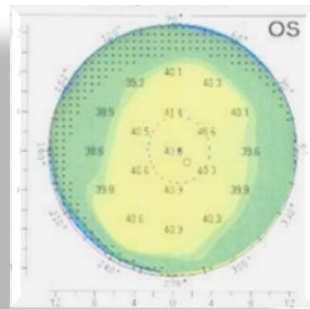
| | Score 3 (Excellent) | Score 2 (Very good) | Score 1 (Fair) | Score 0 (Poor) |
|--------------------------------|--------------------------------|---|---|--|
| Visual Acuity | <i>(BCVA 1.0 or better)</i> | <i>(BCVA 0.9)</i> | <i>(BCVA 0.8)</i> | <i>(BCVA decreased after surgery)</i> |
| Clarity of Vision | <i>Clear Vision</i> | <i>Minimal fogging</i> | <i>Moderate fogging</i> | <i>Marked fogging</i> |
| Symptoms of Dry eye | <i>Absent</i> | <i>Minimal and not annoying patient</i> | <i>Annoying patient but disappear by medications</i> | <i>Annoying patient and persist inspite of medications</i> |
| Night hallows and glare | <i>No hallows or glare</i> | <i>Minimal hallows but not annoying the patient</i> | <i>Present but not restricting patient activities</i> | <i>Present and restrict patient activities</i> |

Table (2): Results of visual acuity

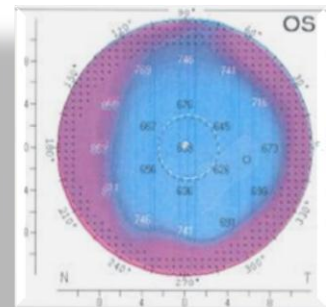
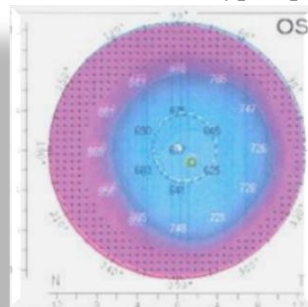
| Follow up | | UCVA | BCVA |
|-----------|-------------------|------------------|------------------|
| One week | - 20/20 or better | -25 eyes (73.5%) | -32 eyes (94.1%) |
| | - 20/30 or better | -31 eyes (91.2%) | -32 eyes (94.1%) |
| | - 20/40 or better | -34 eyes (100%) | -34 eyes (100%) |
| One month | - 20/20 or better | -29 eyes (85.3%) | -33 eyes (97.1%) |
| | - 20/30 or better | -32 eyes (94.1%) | -33 eyes (97.1%) |
| | - 20/40 or better | -34 eyes (100%) | -34 eyes (100%) |
| Six month | - 20/20 or better | -29 eyes (85.3%) | -33 eyes (97.1%) |
| | - 20/30 or better | -32 eyes (94.1%) | -33 eyes (97.1%) |
| | - 20/40 or better | -34 eyes (100%) | -34 eyes (100%) |
| One year | - 20/20 or better | -30 eyes (88.2%) | -33 eyes (97.1%) |
| | - 20/30 or better | -32 eyes (94.1%) | -33 eyes (97.1%) |
| | - 20/40 or better | -34 eyes (100%) | -34 eyes (100%) |

Table (3): Results of refraction

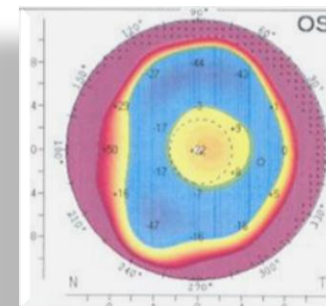
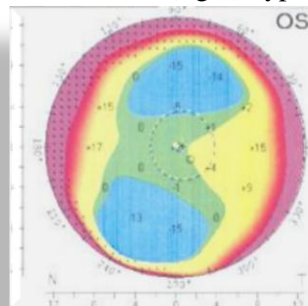
| Refraction | Pre-LASIK | One month post-LASIK | One year post-LASIK |
|----------------------|------------------|-----------------------------|----------------------------|
| Spherical error | +3.4 ± 1.2 D | +0.60±0.33D | +0.75±0.40 D |
| Cylindrical error | -0.6 ± 0.3D | -0.24±0.16 D | -0.22±0.15 D |
| Spherical equivalent | +3.1 ± 1.1 D | +0.53±0.28 D | +0.62±0.31 D |



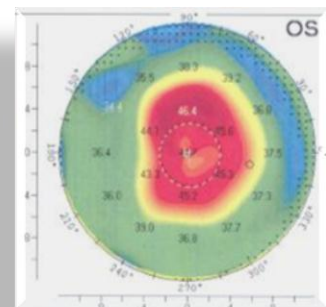
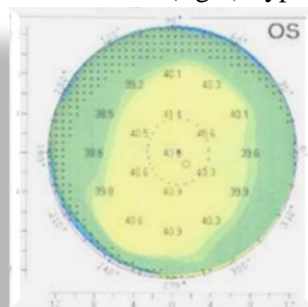
(Fig 1 & 2): Axial curvature front of case 2 before (left) and after (right) hyperopic Lasik correction.



(Fig 3 & 4): Corneal thickness of the same case before (left) and after (right) hyperopic Lasik correction.

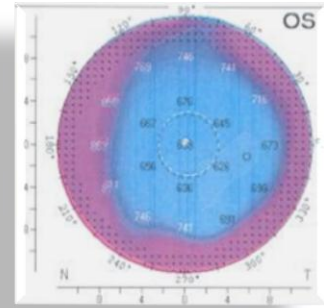
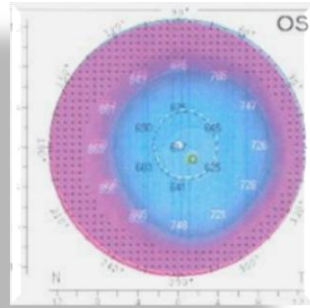


(Fig 5 & 6): Elevation front of the same case before (left) and after (right) hyperopic Lasik correction.

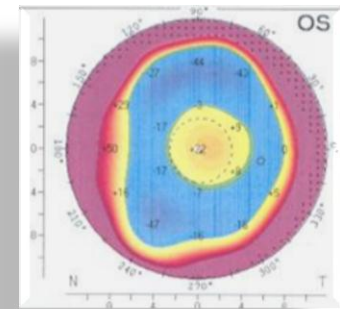
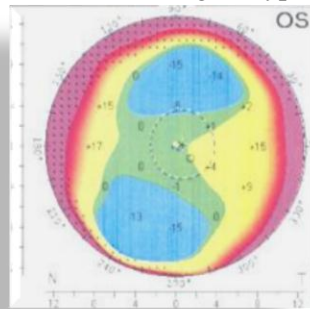


(Fig 7 & 8): Axial curvature front of case 14 before (left) and after (right) hyperopic Lasik correction.

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(Fig 9 & 10): Corneal thickness of the same case before (left) and after (right) hyperopic Lasik correction.



(Fig 11 & 12): Elevation front of the same case before (left) and after (right) hyperopic Lasik correction.