

# Laser in situ keratomileusis for anisometropia in adult patients

Haili Li,<sup>1</sup> MD, Ph D, Guy Chan,<sup>2</sup> MD, FACS

<sup>1</sup> Department of Ophthalmology, The First Teaching Hospital, Medical College of Peking University, Beijing, China.

<sup>2</sup> The Refractive Surgery Centre, Hong Kong Sanatorium & Hospital, Hong Kong, China.

## Correspondence and reprint requests:

Haili Li, MD, Ph D, Department of Ophthalmology, The First Teaching Hospital, Medical College of Peking University, Xi Shiku Street No. 8, Beijing, 100034, China.

## Abstract

**Aims:** To evaluate the visual and refractive results of laser in situ keratomileusis in adult patients with anisometropia, and to assess the predictability, safety, and efficacy of the procedure.

**Patients and methods:** 40 eyes of 25 patients aged 19 to 55 years with myopic anisometropia with or without astigmatism and amblyopia underwent laser in situ keratomileusis. Preoperative mean spherical and cylindrical refraction was  $-11.70 \pm 4.78$  D (range,  $-3.75$  to  $-22.00$  D) and  $1.98 \pm 1.48$  D (range, 0 to 6.00 D), respectively. The mean preoperative spherical and cylindrical refraction difference between the 2 eyes of each patient was  $7.47 \pm 3.76$  D (range, 2.50 to 16.50 D) and  $1.21 \pm 1.44$  D (range, 0 to 5.75D), respectively. Best spectacle-corrected visual acuity ranged from counting fingers to 20/20 (median, 20/30).

**Results:** Postoperatively, all eyes had reduced anisometropia. Spherical manifest refraction ranged from 1.50 to  $-11.00$  D (mean  $-1.24 \pm 2.02$  D). Mean cylindrical refraction was  $0.58 \pm 0.62$  D (range, 0 to 2.25 D). The mean spherical and cylindrical refraction difference between the 2 eyes of each patient was  $1.49 \pm 1.36$  D (range, 0 to 5.75 D) and  $0.65 \pm 0.71$  D (range, 0 to 2.25 D), respectively. Best spectacle-corrected visual acuity ranged from counting fingers to 20/20 (median, 20.0/22.5) postoperatively. Best spectacle-corrected visual acuity of 31 eyes (77.5%) increased by 1 to 7 lines. Among 22 amblyopic eyes, 14 eyes (63.6%) achieved 20/25 or 20/20. There were no significant complications following the procedure

**Conclusion:** Laser in situ keratomileusis was safe, effective, and predictable for correction of anisometropia in adult patients.

**Key words:** Laser in situ keratomileusis, Anisometropia

## Introduction

Anisometropia is a condition in which there is a difference in refractive power between the eyes of a patient. The disparity between image magnification on 2 retinas is known as aniseikonia. Generally, spectacle wearers experience symptoms when approximately 3.00 D of difference exists in spherical or cylindrical correction. Anisometropia can compromise patients' binocular function, and may result in headache, photophobia, tearing, diplopia, or blurred vision.<sup>1</sup>

Among the many methods available to correct anisometropia is correction with spectacles or contact lenses. When spectacles are used, the difference in image formed by either eye prevents perfect fusion of the 2 images, causing loss of binocular vision and usually amblyopia in the affected eye. Many of these patients cannot tolerate full correction with spectacles because of aniseikonia. Undercorrection becomes mandatory to decrease these symptoms but reduces the visual acuities. Contact lenses are the most realistic modality for correction of significant anisometropia and they give more satisfactory visual results than spectacles. Both soft and gas-permeable contact lenses are effective and commonly used for visual rehabilitation of patients who cannot tolerate spectacles.

However, contact lens correction is not always possible for patients requiring visual correction. In many cases, lens

intolerance and inability to adapt to the lenses lead to failure of therapy and development of amblyopia. Contact lens intolerance may be caused by ocular, occupational, and systemic factors. Patients with dry eyes, blepharitis, lid abnormalities, and corneal neovascularization may not tolerate contact lenses. Occupational concerns include exposure to environmental factors such as wind, water, smoke, and poor sanitary conditions. Poorly motivated or disabled patients are also poor candidates for contact lenses. Refractive surgery may be a better alternative for these patients. In recent years, many surgical procedures such as refractive keratotomy (RK), photorefractive keratectomy (PRK), laser in situ keratomileusis (LASIK), intracorneal rings (ICR), phakic lens, clear lens extraction, and intraocular lens implantation have been used to treat myopia. Laser in situ keratomileusis is a potential alternative treatment for anisometropia. This paper presents our results assessing the efficacy, stability, and safety of LASIK in treating myopic and astigmatic anisometropia.

## Patients and methods

A total of 25 anisometropic patients (18 women and 7 men) underwent LASIK between July 1996 and February 2000 at the Hong Kong Sanatorium & Hospital, in the Department of Ophthalmology, Refractive Surgery Center. The mean age of the patients was  $34.12 \pm 8.33$  years (range, 19 to 55 years). Nineteen patients had worn contact lenses for  $8.79 \pm 5.22$  years (range, 2 to 20 years). They stopped wearing the contact lenses at least 1 week before LASIK was performed.

Preoperative examination included uncorrected visual acuity, spectacle-corrected visual acuity by manifest refraction, cycloplegic refraction, slit-lamp microscopy, applanation tonometry, dilated fundoscopy, corneal topography, and pachymetry. Forty eyes of 25 patients with myopia with or without astigmatism underwent LASIK. Fifteen patients had bilateral LASIK performed. The mean preoperative spherical refraction was  $-11.70 \pm 4.78$  D (range,  $-3.75$  to  $-22.00$  D). The amount of preoperative astigmatism ranged from 0 to  $+6.00$  D (mean,  $1.98 \pm 1.48$  D). The mean preoperative spherical and cylindrical refractive difference between the 2 eyes of patients was  $7.47 \pm 3.76$  D (range, 2.50 to 16.50 D) and  $1.21 \pm 1.44$  D (range, 0 to 5.75D), respectively. The mean preoperative corneal thickness was  $544.23 \pm 34.72$  mm (range, 478.00 to 613.00 mm). Uncorrected visual acuity (UCVA) ranged from hand movement (HM), to 20/200. Preoperative best spectacle-corrected visual acuity (BCVA) ranged from counting fingers (CF) to 20/20 with a median of 20/30. Sixteen eyes could achieve 20/25 or better — 20/20 in 4 eyes and 20/25 in 12 eyes. Twenty four eyes had BCVA of 20/30 or worse — 20/30 in 8 eyes, 20/40 in 9 eyes, and less than 20/40 in 7 eyes. Amblyopia was diagnosed if BCVA was 20/30 or worse in the amblyopic eye and was not attributable directly to any underlying structural abnormality of the eye or visual pathway. Excluding 2 patients with extra high myopia and macular atrophy whose BCVA was CF and 20/30, there were 22 amblyopic eyes diagnosed. The mean preoperative spherical refraction

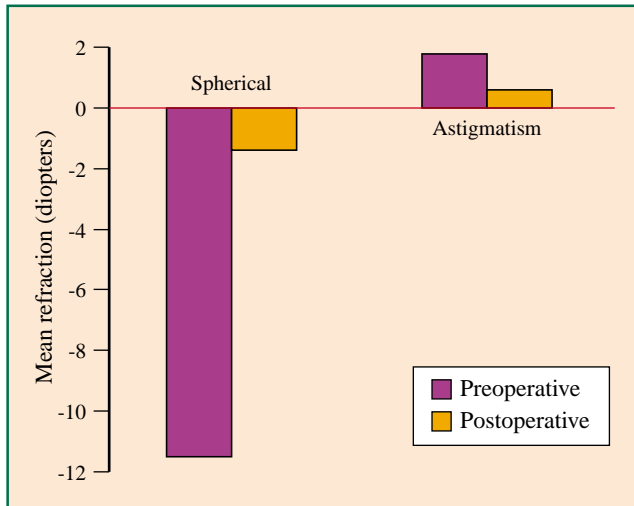
and astigmatism of these eyes were  $-13.36 \pm 3.48$  D (range,  $-4.25$  to  $-22.00$  D) and  $2.50 \pm 1.29$  D (range, 0.75 to 6.00), respectively. The same surgeon performed all the surgeries. After using the automated corneal shaper (Chiron, Claremont, USA) to create a flap, laser ablation was performed in the stromal corneal bed using the Chiron Technolas keracor 217 excimer laser. The plate size was 130 mm (20 eyes) or 160 mm (20 eyes). The mean ablation zone was  $5.09 \pm 0.54$  mm (range, 4.00 to 6.00 mm). The mean central ablation depth was  $172.45 \pm 41.38$  mm (range, 64.00 to 241.00 mm).

After completing the laser ablation, the surgeon irrigated the corneal bed surface, placed back the flap and dried it for 3 to 4 minutes, tested adequate adherence, and removed the speculum. A plastic eye shield was applied postoperatively for 1 day. The patients were instructed to avoid rubbing the operated eye. Postoperative treatment included the use of Tobradex eye drops 4 times a day for 4 weeks. Non-preserved artificial tears were used as required for a prolonged period. Follow-up examinations were scheduled at 1 day, 1 week, 1, 3, and 6 months, and 1 and 2 years. At each routine examination, manifest refraction, UCVA and BCVA, Goldman tonometry and slit-lamp biomicroscopy were performed. Corneal topography was examined at 6 months after surgery. All p-values were obtained from Student's t-test.

## Results

There were no intraoperative complications. Patients were followed up for 3 to 36 months (mean,  $15.60 \pm 8.52$  months). Three eyes with undercorrection underwent enhancement (2 at 10 months and 1 at 6 months after surgery). Thirty four eyes had a mean sphere of  $-1.03 \pm 1.76$  D at 3 months. Thirty two eyes had a mean sphere of  $-1.23 \pm 2.14$  D at 6 months, 26 eyes had mean sphere of  $-1.41 \pm 2.51$  D at 1 year, and 16 eyes had a mean sphere of  $-1.88 \pm 2.80$  D at 2 years. There was no statistical difference in the postoperative sphere at these periods ( $p > 0.01$ ). At the last follow-up, the mean postoperative spherical refraction was  $-1.24 \pm 2.02$  D (range, 1.50 to  $-11.00$  D). Twenty eyes (50%) had a postoperative spherical manifest refraction within  $\pm 1.00$  D. The mean postoperative cylindrical refraction was  $0.58 \pm 0.62$  D (range, 0 to 2.25 D). The mean changes in spherical and cylindrical refraction of surgical eyes were  $10.34 \pm 3.85$  D (range, 3.00 to 19.00 D) and  $1.43 \pm 1.5$  D (range,  $-1.25$  to 5.52 D), respectively. The changes were statistically significant ( $p < 0.001$ ) [Figure 1].

The mean postoperative spherical and cylindrical refractive differences between the 2 eyes of each patient were  $1.49 \pm 1.36$  D (range, 0 to 5.57 D) and  $0.65 \pm 0.71$  D (range, 0 to 2.25 D), respectively — statistically significantly lower than the preoperative value ( $p < 0.001$ ) [Figure 2]. After surgery, the UCVA ranged from CF to 20/20. Twenty four eyes (60%) achieved a significant improvement in UCVA to 20/40 or better. The BCVA ranged from CF to 20/20 with a median of 20.0/22.5, postoperatively. There was a



**Figure 1.** Changes in mean spherical and astigmatic refraction after laser in situ keratomileusis.

statistically significant difference in the BCVA between preoperative and postoperative eyes ( $p < 0.001$ ). The BCVA remained the same in 8 eyes (20.0%), increased by 1 to 7 lines in 31 eyes (77.5%), and decreased by 1 line in 1 eye (2.5%) with macular disease (Figure 3). Among 22 amblyopic eyes, 14 eyes (63.6%) achieved 20/25 or 20/20, 8 eyes (36.4%) had 20/30 or less — 20/30 in 4 eyes, 20/40 in 3 eyes, and 20/70 in 1 eye.

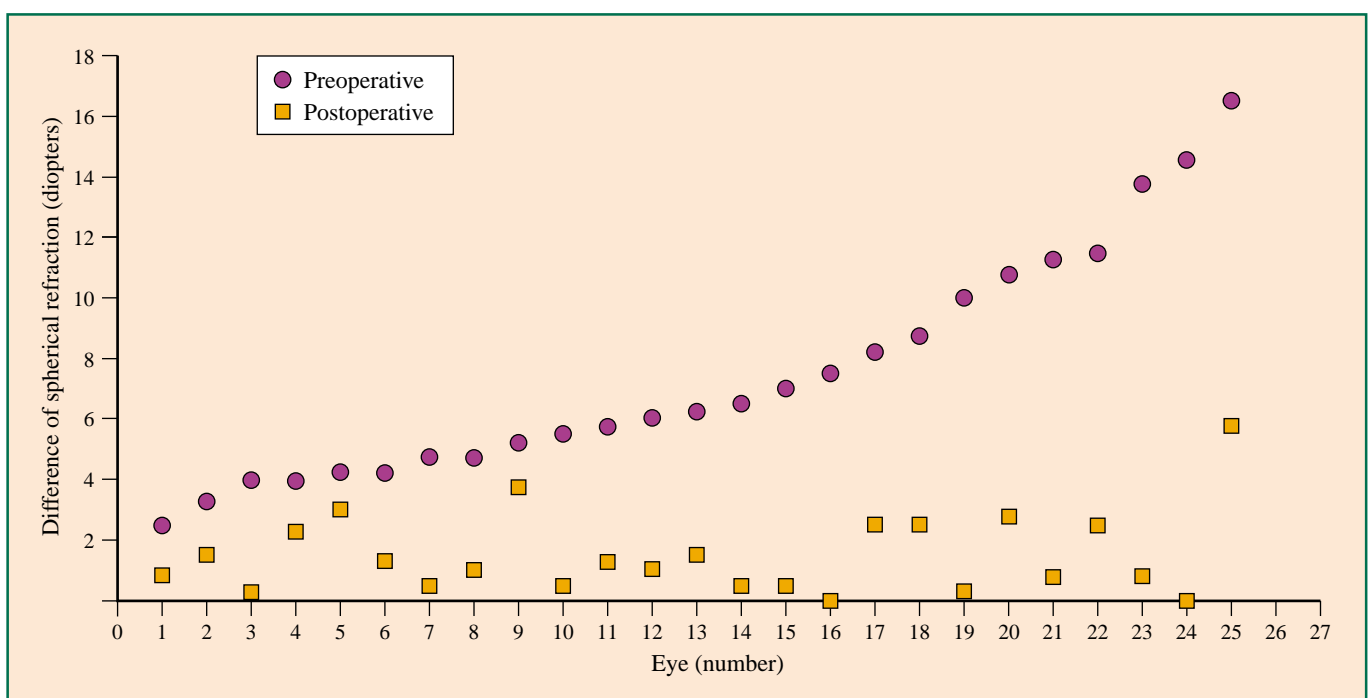
After LASIK, the central corneal thickness was reduced to a mean of  $440.97 \pm 43.90$  mm (range, 333.00 to 544.00 mm) [ $p < 0.001$ ]. The preoperative intraocular pressure (IOP) ranged from 10.00 to 20.00 mm Hg with a mean of  $14.86 \pm 3.22$  mm Hg. After LASIK, the IOP was reduced to a mean of  $13.19 \pm 2.32$  mm Hg (range, 10.00 to 17.00 mm Hg) [ $p > 0.01$ ]. None of the eyes developed a secondary rise in

IOP due to topical corticosteroids. Four eyes had transient trace haze approximately 4 weeks after surgery, and became clear after treatment with fluorometholone eye drops 3 times a day for 2 months. There was no flap complication such as epithelial ingrowth, flap striae, free flap, or flap melt. Examination of the corneal topography showed proper centration of laser ablation in all eyes. There were no irregular astigmatism or central islands.

All patients reported some relief of asthenopic complaints such as tearing, headache, and blurred vision. Twenty two patients (88%) were happy with the results in a postoperative questionnaire. Three less satisfied patients included 1 patient with loss of 1 line of vision because of macular disease, 1 patient had undercorrection because of extreme high myopia (-21.75 D), and 1 patient had double vision because of exotropia, which required muscle surgery.

### Discussion

Previously, patients with anisometric myopia and astigmatism were fitted with contact lenses to decrease aniseikonia. In recent years, however, refractive surgical procedures such as RK, PRK, and LASIK have been used to treat myopia and astigmatism, especially for patients with contact lens and spectacle intolerance. Ahmet et al reported the results of unilateral RK in 20 eyes of 20 patients aged between 18 and 60 years.<sup>2</sup> Some authors have reported the results of PRK in children with amblyopia resulting from anisometropia in which conventional therapy was unsuccessful, and the results in adult patients with anisometropia induced by previous retinal detachment surgery.<sup>3-5</sup> PRK, especially in high myopia, may result in the development of corneal haze, regression of refractive result, or reduction of best spectacle-corrected visual acuity.



**Figure 2.** Comparison of preoperative and postoperative refractive difference of sphere between 2 eyes.

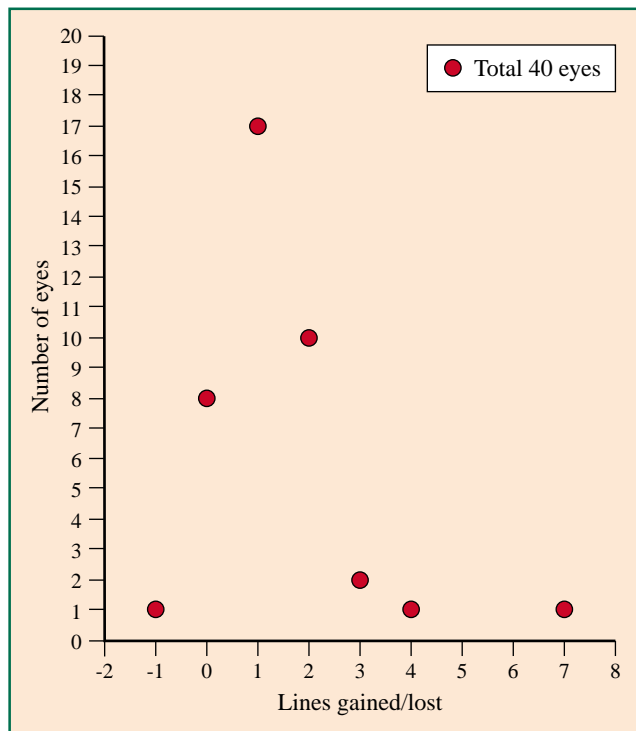


Figure 3. Lines of visual acuity gained/lost after LASIK.

LASIK, on the other hand, maintains the integrity of Bowman's layer and gives more predictable and stable refractive results than PRK. Many studies have reported that LASIK for myopia and astigmatism is safe, effective, stable, and predictable. To date, few studies have reported the results of LASIK in anisometric patients. Khaled reported the results of LASIK in pediatric patients with myopic anisometropia and amblyopia.<sup>6</sup> In these patients, LASIK yielded good results, and there were no significant complications. Donnenfeld et al reported the results of LASIK in 23 eyes of 22 patients after penetrating keratoplasty.<sup>7</sup> At present, there is no report of LASIK for anisometropia in adult patients without other corneal surgery who could not tolerate spectacles and contact lenses.

In our study, the patients had myopic anisometropia with or without astigmatism and amblyopia. We attempted to decrease anisometropia by performing LASIK on one or both eyes and tried to improve the BCVA of amblyopic patients. The results of LASIK in these patients showed

that the procedure is safe, effective, and predictable in this condition. The mean spherical manifest refraction was reduced from  $-11.70 \pm 4.78$  D preoperatively to  $-1.24 \pm 2.02$  D after LASIK. Twenty eyes (50%) had a postoperative spherical manifest refraction within  $\pm 1.00$  D. The amount of refractive astigmatism was reduced from a mean of  $1.98 \pm 1.48$  D preoperatively to a mean of  $0.58 \pm 0.62$  D after surgery. Even though there was a small amount of residual postoperative myopia in some patients, decreasing the difference in refractive error between the 2 eyes allowed patients to wear spectacles more comfortably and improved the visual acuity in the operated eye. The refractive results in this study showed relative stability after 2 years.

One of the main criteria of success in LASIK for anisometropia is the decrease of refractive difference between the two eyes. The mean preoperative spherical and cylindrical refraction difference between the two eyes was  $7.47 \pm 3.76$  D and  $1.21 \pm 1.44$  D, respectively, which decreased to  $1.49 \pm 1.36$  D and  $0.65 \pm 0.71$  D, respectively, after surgery. When considering the common belief that up to 3.00 D difference is tolerated by most people, LASIK for anisometropia can be recommended from 3.00 to 14.50 D of myopic anisometropia. Our result, suggest that LASIK is effective for the treatment of anisometropia.

Interestingly, 31 eyes (77.5%) had an increase in spectacle-corrected visual acuity, by 1 line in 17 eyes, by 2 lines in 10 eyes, and by more than 2 lines in 4 eyes. Twenty four eyes (60.0%) achieved a significant improvement in uncorrected visual acuity to 20/40 or better. This improvement may be due to less image size reduction and optical aberrations caused by high minus spectacles. Among the 22 amblyopic eyes, 14 (63.6%) achieved BCVA of 20/25 or better after LASIK. Therefore, LASIK is also helpful for improving amblyopia.

## Conclusion

LASIK for anisometropia can result in good patient satisfaction with improvement in anisometropia and visual acuities. In patients with refractive anisometropia, it is reasonable to perform LASIK to equalize the refraction with the goal of decreasing the anisometropia, especially in spectacle and contact lens intolerant patients.

## References

1. Rubin ML. Anisometropia. In: Fraunfelder FT, Roy FH, Grove J, editors. *Current ocular therapy*. Philadelphia, PA: WB Saunders Company; 1995:757-758.
2. Ahmet M, Esin FE, Ferit HO. Unilateral refractive keratotomy for anisometropia. *J Refract Surg* 1998;14:325-330.
3. Alio JL, Artola A, Claramonte P, et al. Photorefractive keratectomy for pediatric myopic anisometropia. *J Cataract Refract Surg* 1998;24:327-330.
4. Nano HD, Muzzin S, Irigaray LF. Excimer laser photorefractive keratectomy in pediatric patients. *J Cataract Surg* 1997;23:736-739.
5. Bilgihan K, Ozdek SC, Gurelik G, et al. Photorefractive keratectomy for visual rehabilitation of anisometropia induced by retinal detachment surgery. *J Refract Surg* 2000;16:75-78.
6. Khaled MR. Laser in situ keratomileusis for myopia anisometropia in children. *J Refract Surg* 1999;15:429-435.
7. Donnenfeld ED, Kornstein HS, Amin A, et al. Laser in situ keratomileusis for correction of myopia and astigmatism after penetrating keratoplasty. *Ophthalmology* 1999;106:1966-1975.