Original Article

Wavefront-Guided Photorefractive Keratectomy for Correction of Residual Refractive Error after Intacs Implantation in Patients with Keratoconus

Mohsen Gohari * [1], MD ; Mohammad Ali Zare Mehrgardy [2], MD

1. Ophthalmology Department, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
2. Farabi Eye Center, Tehran University of Medical Sciences, Tehran, Iran.

***Corresponding Author:** Mohsen Gohari
E-mail: goharimo@yahoo.com

Article Notes:
Received: May. 15, 2017
Received in revised form: Jun. 5, 2017
Accepted: Jun. 20, 2017
Available Online: Jun. 24, 2017

Keywords:
Photorefractive
Keratectomy
Intracorneal ring segment
Keratoconus
Residual
Refractive error

Abstract

Purpose: To evaluate the efficacy of Wavefront-guided photorefractive keratectomy (PRK) for correction of residual refractive error after intrastromal corneal ring segments (ICRS) insertion for treatment of keratoconus.

Patients and Methods: In this prospective study five eyes of 5 keratoconus patients who had previous ICRS implantation (four Intacs TM and one Keraring), underwent Wavefront-guided PRK to correct residual refractive error.

Results: Three months postoperatively, the mean spherical equivalent (SE) improved from 2.07 ± 1.38 Diopter to - 0.87 ± 0.54 Diopter. Four out of 5 eyes were within ± 1.00 Diopter of Plano refraction. Three eyes had UCVA of 20/30 or better (all eyes; 20/40 or better). After 6 months, the mean SE was - 0.75 ± 0.50 Diopter and all eyes were within ± 1.00 Diopter of Plano refraction. UCVA was 20/20 in 2 eyes, 20/30 or better in 2 eyes and 20/40 in one eye. One patient lost one line of BCVA.

Conclusion: This study series showed that wavefront-guided PRK might be an effective procedure for correction of residual refractive error after ICRS insertion in keratoconus patients. Improvement in UCVA was seen in all cases after PRK without any complications and haze.

How to cite this article: Gohari M, Zare Mehrgard MA. Wavefront-Guided Photorefractive Keratectomy for Correction of Residual Refractive Error after Intacs Implantation in Patients with Keratoconus. Journal of Ophthalmic and Optometric Sciences. 2017;1(4):22-8.

Introduction

Keratoconus, described more than one century ago is a non inflammatory, progressive ectatic disease of the cornea [1,2]. In its early stages, spectacles and contact lenses are the usual treatment modalities. In cases of progressive keratoconus and among patients who become contact lens intolerant several surgical strategies including intrastromal corneal ring segments (ICRS) implantation, collagen cross-linking (CCL) and lamellar keratoplasty have been proposed to improve visual function [3,4]. Intacts offer a unique surgical alternative for treating contact lens intolerant patients with clear cornea keratoconus. Intrastromal Corneal Ring Segment (ICRS) implantation is a safe and effective treatment for patients with mild to moderate keratoconus and central clear cornea [1,5]. But ICRS only corrects a limited range of myopia and high refractive errors, commonly seen in patients with keratoconus, may remain [6]. Available options for correction of the residual refractive error are spectacles, contact lens implantation and surgical procedures such as PRK [7]. In this study we report the results of PRK in keratoconus p tients with previous ICRS implantation to correct residual refractive error. To our knowledge there is limited number of reports concerning the efficacy of PRK for correcting residual refractive errors after ICRS implantation in keratoconus patients.

Patients and Methods

In this prospective non-comparative study, we evaluated the safety and efficacy of PRK performed in five eyes of five keratoconus patients, for correction of residual refractive errors after ICRS implantation. All patients were male and had previously undergone ICRS implantation (four eyes Intacs ™ and one eye Keraring). Inclusion criteria were residual refractive error resulting in significant visual loss and patient's dissatisfaction from the results; clear central cornea; stable refraction; central pachymetry more than 400 μm and at least 6 months being passed since ICRS implantation. Exclusion criteria were untreated lid margin disease or tear film abnormalities, presence of central or paracentral corneal leucoma, intraocular pressure > 21 mmHg or glaucoma, systemic diseases (autoimmune disorders, atopia and diabetes mellitus), history of any ocular disease (except keratoconus) and complicated ICRS implantation. The options for correcting the residual refractive error including using spectacles or contact lens, removing the Intacs and PRK over the Intacs were discussed with all patients. All patients in this study chose PRK. Written informed consent was obtained from all patients before undertaking PRK. This study was approved by the ethics committee of Tehran University of Medical Sciences, Tehran, Iran.

Before refractive surgery, a comprehensive ophthalmic examination was performed including uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BSCVA), subjective refraction, slit lamp examination, tonometry, fundoscopy, Visante optical coherence topography (OCT), ultrasound pachymetry for measuring corneal thickness especially in optical zone, Pentacam (Oculus Inc. Wetzlar, Germany) and wavefront aberrometry (iTrace (Tracey Technologies Corp. TX, USA). UCVA and BSCVA were obtained using a Snellen chart and were defined according to LogMAR for statistical analysis. All patients were examined one day, one week, one month, three months and six months after PRK. Patients were evaluated for visual and refractive outcome and aberration changes and probable complications. If there were any complications in addition to

routine examinations a complete ophthalmic examination was performed. Statistical analysis was performed using SPSS software version 22 (IBM, Armonk, NY, USA).

Surgical technique

A 5 % concentration of povidone-iodine solution was used for periocular disinfection. Operative field was exposed by a lid speculum. The epithelium was removed gently after contact with 20 % alcohol solution for 20 seconds. Wavefront guided laser ablation was performed using Technolas laser (217z Zyoptix, Bausch & Lomb Inc. New York, USA) and a customized laser ablation pattern. Maximum ablation depth was 50 µm and optical zone was 5.8 mm. After the ablation, a sponge soaked with 0.02 % mitomycin solution was applied for 30 seconds. The eye was then irrigated and a soft contact lens bandage was placed over the eye. Topical levofloxacin, betamethasone and Artelac were started for all patients postoperatively. Contact lens was removed as soon as epithelium was repaired.

Results

Five eyes of 5 patients (all men) underwent an uneventful PRK procedure over ICRS implantation and the results were followed for 6 months. The mean age of patients was 21 ± 3.21 years (range 21 to 29 years). The mean pre-operative UCVA and BCVA were 0.51 ± 0.14 LogMAR (range 0.30 to 0.70 LogMAR) and 0.07 ± 0.13 LogMAR (range 0.0 to 0.30 LogMAR) respectively. The mean manifest spherical equivalent (SE) refraction before the PRK was - 2.07 ± 1.38 diopters (D) (range, - 3.75 to - 0.25 D). The mean cylinder before the PRK was - 2.85 ± 1.22 D (range, - 4.50 to - 1.25 D). The mean keratometry (K) reading was 45.74 ± 3.38 D (range, 42.30 to 49.80).

Complete examination of all eyes was performed 3 months and 6 months after PRK. At the 3-month examination, the mean UCVA was 0.18 ± 0.06 LogMAR (range 0.30 to 0.15 LogMAR), the mean BSCVA was 0.05 ± 0.06 LogMAR (range 0.15 to 0.00 LogMAR), and the mean SE was - 0.87 ± 0.54 D (range - 1.50 to 0.00 D). The mean keratometry (K) reading was 44.34 ± 3.50 D (range, 40.30 to 48.60). At the 6-month examination, the mean UCVA was 0.11 ± 0.12 LogMAR (range 0.30 to 0.00 LogMAR), the mean BSCVA was 0.08 ± 0.12 LogMAR (range 0.30 to 0.00 LogMAR), and the mean SE was - 0.75 ± 0.50 D (range - 1.12 to 0.13 D). The mean keratometry (K) reading was 43.23 ± 2.80 D (range, 39.75 to 46.50). Pre and post-operative data is presented in table 1. There were no wound healing problems or any signs that the PRK procedure had adversely affected the cornea. There were no complications.

Discussion

Although ICRS implantation is an effective method for improving visual acuity in keratoconus patients [5] it cannot always correct high refractive errors and astigmatism frequently seen in these patients [6] and the successful rate of surgery is 70 % . Available options for correction of residual refractive error after ICRS implantation include: spectacle prescription, contact lens, ICRS removal, IOL implantation and refractive surgery. Spectacles or contact lenses have a negative impact on quality of life [8,9]. Contact lens users also may lose their tolerance and have the risk of contact lens-wearing complications [3,4,10].

There are some reports regarding the results of refractive surgery over ICRS or after its removal in myopic patients [11-15].

Based on these limited number of studies, refractive surgery with ICRS in place or after its extraction can be used safely and effectively. Tan Bu et al.,[12] used PRK for correction of residual refractive error over Intacs. PRK was performed in 8 eyes of 5 patients who had Intacs for low myopia correction [12]. Three months after PRK all patients had Plano refraction with UCVA of 20/20 or better and in last follow-up (2 years) all patients had near Plano vision (20/10 to 20/25) [12]. In their study the incidence of haze formation was high [12]. In comparison, our patients had higher residual refractive error and PRK was performed in patients with a history of keratoconus. Moreover no haze formation was seen among our patients. This can be explained by application of mitomycin C for all our patients.

Refractive surgery is contraindicated in keratoconus patients but there are reports on safety and efficacy of refractive surgery after ICRS implantation or corneal collagen crosslinking (CXL) among these patients [6,16-25]. One study indicated that combined topography-guided transepithelial PRK with intracorneal ring segments implantation and CXL in a three-step procedure is an effective treament for improving functional visual acuity and stopping the progression of the ectatic disorder [19]. In another study combination of ICRS implantation followed by sequential same-day topography-guided PRK/CXL was used as a reasonable option for improving visual acuity in keratoconus patients [18]. Guell et al., [6] in a case series of ICRS implantation in mild to moderate keratoconus, reported PRK over ICRS in one eye. The only complication was a hyperopic shift due to severe epithelial hyperplasia in the mid-periphery of the cornea that acted as a negative lens [6]. Kymionis et al., [16] reported CXL and topography-guided PRK as the most effective method among keratoconus patients. They suggested simultaneous CXL and topography-guided PRK as a promising treatment capable of offering significant improvement in all parameters (UCVA, BSCVA, SE, keratometry) [16]. Dirani et al., [11] evaluated the safety and efficacy of non-topography–guided PRK for treatment of residual mild refractive errors after sequential ICRS implantation and CXL in 17 eyes of 14 patients with mild to moderate stable keratoconus. At the 6-month follow-up after PRK, UDVA significantly improved to 0.18 ± 0.06 LogMAR and CDVA was 0.15 ± 0.05 LogMAR [11]. The mean spherical error and mean cylinder significantly decreased to - 1.10 ± 0.41 D and 0.98 ± 0.37 D, respectively and no complications were seen intraoperatively or postoperatively [11]. They suggested that non-topography–guided PRK is an effective and safe option for correcting residual refractive error and improving visual acuity in patients with moderate keratoconus [11]. In a study by Hirsh and et al., [26] LASEK was performed for correction of residual myopia and astigmatism in four keratoconus patients with previous Intacs implantation. The mean refraction before LASEK was - 0.2 diopter for myopia and - 2.71 diopter for keratoconus [26]. The mean followup after surgery was 8 months. The mean UCVA was 6/12 (range: 6/18 - 6/10) and the mean BSCVA was 6/9 (range: 6/12 - 6/8.5) in the last visit [26]. These researchers suggested that wavefront-guided LASEK for correction of residual refractive error in keratoconus patients after Intacs mplantation will result in excellent visual outcomes without loss of visual acuity and complications [26]. In our study in five keratoconus patients having ICRS (4 Intacs and 1 Keraring), wavefront guided PRK was performed for correction of

residual refractive error. Our results indicated improvement in visual outcomes. No complications were seen during PRK and in the follow up period. Visual and refractive outcomes in two patients were less desirable than others. These patients had hyperopia and high astigmatism. It seems that PRK after Intacs implantation in kera toconus patients may be more successful in patients with low to moderatemyopia and low astigmatism.

Conclusion

This case series showed that wavefront-guided PRK might be an effective procedure for correction of residual refractive error after ICRS implantation in keratoconus patients. Significant improvement in UCVA was seen in all cases after PRK without any complications and haze.

References

1. Gordon-Shaag A, Millodot M, Shneor E. The epidemiology and etiology of keratoconus. Int J Keratoco Ectatic Corneal Dis. 2012;1:7-15.

2. Grzybowski A, McGhee CN. The early history of keratoconus prior to Nottingham's landmark 1854 treatise on conical cornea: a review. Clin Exp Optom. 2013;96(2):140-5.

3. Espana EM, Tseng SC. Analysis of contact lens intolerance by exploring neuroanatomic integration of ocular surface defense. Contact Lens and Anterior Eye. 2003;26(3):131-7

4. Glasson MJ, Stapleton F, Keay L, Sweeney D, Willcox MD. Differences in clinical parameters and tear film of tolerant and intolerant contact lens wearers. Investigative ophthalmology & visual science. 2003;44(12):5116-24.

5. Colin J. European clinical evaluation: use of Intacs for the treatment of keratoconus. J Cataract Refract Surg. 2006;32(5):747-55.

6. Güell JL, Morral M, Salinas C, Elies D, Gris O, Manero F. Four-year follow-up of intrastromal corneal ring segments in patients with keratoconus. J Emmetropia. 2010;1:9-15.

7. Uçakhan ÖÖ, Kanpolat A, Özdemir Ö. Contact lens fitting for keratoconus after Intacs placement. Eye & contact lens. 2006;32(2):75-7.

8. Chen CY, Keeffe JE, Garoufalis P, Islam FM, Dirani M, Couper TA, Vision-related quality of life comparison for emmetropes, myopes after refractive surgery, and myopes wearing spectacles or contact lenses. J Refract Surg. 2007;23(8):752-9.

9. Pesudovs K, Garamendi E, Elliott DB. A quality of life comparison of people wearing spectacles or contact lenses or having undergone refractive surgery. J Refract Surg. 2006;22(1):19-27.

10. Beljan J, Beljan K, Beljan Z. Complications caused by contact lens wearing. Coll Antropol.2013;37 Suppl 1:179-87.

11. Gomez L, Chayet A. Laser in situ keratomileusis results after intrastromal corneal ring segments (Intacs). Ophthalmology. 2001;108(10):1738-43.

12. Tan BU, Purcell TL, Nalgirkar A, Ehrenhaus MP, Torres LF, Schanzlin DJ. Photorefractive keratectomy for the correction of residual refractive error with Intacs intrastromal corneal ring segments in place. Journal of Cataract & Refractive Surgery. 2008;34(6):909-15.

13. Asbell PA, Ucakhan OO, Odrich M. Photorefractive keratectomy after intrastromal corneal ring segment explantation. Am J Ophthalmol. 1999;128(6):755-6.

14. Ito M, Arai H, Fukumoto T, Toda I, Tsubota K. INTACS before or after laser in situ 47 keratomileusis: correction of thin corneas with moderately high myopia. J Refract Surg. 2004;20(6):818-22.

15. Mian SI, Jarade EF, Scally A, Azar DT. Combined ICRS insertion and LASIK to maximize postoperative residual bed thickness in high myopia. J Cataract Refract Surg. 2004;30(11):2383-90.

16. Kymionis GD, Kontadakis GA, Kounis GA, Portaliou DM, Karavitaki AE, Magarakis M, et al. Simultaneous topography-guided PRK followed by corneal collagen cross-linking for keratoconus. Journal of Refractive Surgery. 2009;25(9):S807.

17. Spadea L, Paroli M. Simultaneous topography-guided PRK followed by corneal collagen cross-linking after lamellar keratoplasty for keratoconus. Clin Ophthalmol. 2012; 6:1793- 58. 29(1):59-63.

18. Al-Tuwairqi W, Sinjab MM. Intracorneal ring segments implantation followed by same- day topography-guided PRK and corneal collagen CXL in low to moderate keratoconus. J Refract Surg. 2013; 29(1):59-63.

19. Coskunseven E, Jankov MR, 2nd, Grentzelos MA, Plaka AD, Limnopoulou AN, Kymionis GD. Topography-guided transepithelial PRK after intracorneal ring segments implantation and corneal collagen CXL in a three-step procedure for keratoconus. J Refract Surg. 2013; 29(1):54-8.

20. Dirani A, Fadlallah A, Syed ZA, Chelala E, Khoueir Z, Cherfan G, et al. Non-topography-guided photorefractive keratectomy for the correction of residual mild refractive errors after ICRS implantation and CXL in keratoconus. J Refract Surg. 2014; 30(4):266-71.

21. Iovieno A, Legare ME, Rootman DB, Yeung SN,

Kim P, Rootman DS. Intracorneal ring segments implantation followed by same-day photorefractive keratectomy and corneal collagen cross-linking in keratoconus. J Refract Surg. 2011; 27(12):915-8.

22. Kanellopoulos AJ. Comparison of sequential vs same-day simultaneous collagen cross- linking and topography-guided PRK for treatment of keratoconus. J Refract Surg. 2009;25(9):S812-8.

23. Kanellopoulos AJ, Binder PS. Management of corneal ectasia after LASIK with combined, same-day, topography-guided partial transepithelial PRK and collagen cross-linking: the athens protocol. J Refract Surg. 2011;27(5):323-4.

24. Kremer I, Aizenman I, Lichter H, Shayer S, Levinger S. Simultaneous wavefront-guided photorefractive keratectomy and corneal collagen crosslinking after intrastromal corneal ring segment implantation for keratoconus. J Cataract Refract Surg. 2012;38(10):1802-7.

25. Yeung SN, Low SA, Ku JY, Lichtinger A, Kim P, Teichman J, et al. Transepithelial phototherapeutic keratectomy combined with implantation of a single inferior intrastromal corneal ring segment and collagen crosslinking in keratoconus. J Cataract Refract Surg. 2013;39(8):1152-6.

26. Hirsh A, Barequet IS, Levinger S. Wavefront-guided lasek after intacs in eyes with stable keratoconus. Harefuah. 2006; 145(3):181-2, 247-8. (Article in Hebrew)

Footnotes and Financial Disclosures

Conflict of Interest:

The authors declare no conflict of interest with the subject matter of the present manuscript.