British Journal of Medicine & Medical Research
18(3): 1-5, 2016, Article no.BJMMR.29500
ISSN: 2231-0614, NLM ID: 101570965

SCIENCEDOMAIN *international*
www.sciencedomain.org

Changes in Anterior Segment Parameters after Penetrating Keratoplasty for Keratoconus

Altay Yesim[1*], Burcu Ayse[2], Balta Ozgur[2] and Ornek Firdevs[2]

[1]Department of Ophthalmology, Ufuk University, Ankara, Turkey.
[2]Department of Ophthalmology, Ankara Training and Research Hospital, Ankara, Turkey.

Authors' contributions

This work was carried out in collaboration between all authors. Author AY designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors BA, BO and FO managed the file reviews and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2016/29500
Editor(s):
(1) Pradeep Venkatesh, Professor, Ophthalmology, All India Institute of Medical Sciences, New Delhi, India.
Reviewers:
(1) Aruna Kumari R. Gupta, CU Shah Medical College, Surendranagar, Gujarat, India.
(2) Hany Ahmed Helaly, Alexandria University, Egypt.
Complete Peer review History: http://www.sciencedomain.org/review-history/16516

Original Research Article

Received 15th September 2016
Accepted 6th October 2016
Published 12th October 2016

ABSTRACT

Aim: To evaluate the influence of penetrating keratoplasty (PK) for keratoconus, on corneal curvatures and the anterior segment parameters obtained with the Pentacam rotating Scheimpflug camera.
Place and Duratıon of Study: Department of Ophthalmology, Ankara Training and Research Hospital, between May 2013 and March 2016.
Methods: Medical records of 38 eyes of 38 patients who underwent PK for keratoconus were reviewed retrospectively. Patients were evaluated preoperatively and postoperatively one month after suture removal (13 months) with Pentacam. We compared measurements of anterior and posterior corneal curvatures, anterior chamber depth (ACD), anterior chamber volume (ACV), anterior chamber angle (ACA) and central corneal thickness. Paired t-test was used for comparison.
Results: Mean anterior keratometry (Km) reading of cornea decreased significantly from 67.73±14.91 diopter (D) before surgery to 40.40±8.74 D at 13 months (*P*=0.0001). Posterior mean K reading of the cornea decreased significantly from -10.82±2.77 D preoperatively to -5.72±1.65 D at 13 months (*P*=0.0001). ACD, ACV and ACA decreased significantly following PK surgery.

**Corresponding author: E-mail: altayye@yahoo.com;*

Conclusion: PK significantly decreased corneal curvatures and ACD, ACV, ACA, resulting in a hyperopic shift. This observation should be taken into consideration when performing a Triple procedure.

Keywords: Anterior segment parameters; corneal curvature; intraocular lens calculation; pentacam; penetrating keratoplasty.

1. INTRODUCTION

Keratoconus is a progressive, non-inflammatory, ectatic disorder which results in visual impairment. The estimated prevalance of keratoconus ranges from 0.08% to 2.3% [1,2]. High irregular astigmatism, increased corneal aberrations and central corneal scarring seen in keratoconus are associated with decreased visual acuity [3].

Surgical treatment is indicated when spectacles and contact lenses fail to provide satisfactory visual function or when patients are contact lens-intolerant [4]. Penetrating keratoplasty (PK) which is the full-thickness replacement of a diseased cornea with an allograft donor cornea, has been a surgical treatment for keratoconus over the past few decades [5,6].

The purpose of this study was to evaluate the influence of penetrating keratoplasty on corneal curvatures and the anterior segment parameters obtained with the Pentacam rotating-Scheimflug camera.

2. MATERIALS AND METHODS

This study was a retrospective, cohort study. Medical records of 38 patients, who underwent penetrating keratoplasty for keratoconus at Eye Clinic of our hospital by a single surgeon, were reviewed. The study protocol was in accordance with the principles of Declaration of Helsinki.

Keratoconus was diagnosed on the basis of clinical slit-lamp findings (stromal thinning, conical protrusion, a Fleisher ring, Vogt striae, and sub-epithelial scarring) and characteristics of topographic pattern. Informed consent form was signed by all keratoconus patients undergoing penetrating keratoplasty. Patients with an uneventful surgery (without intraoperative and postoperative complications such as suture loosening, suture related infection, graft rejection. etc.) and follow-up for at least one year were included in the study.

Patients with episodes of rejection, with intraoperative or postoperative complications (inluding suture loosening and re-suturing) and shorter than 1 year follow-up were exluded from the study. No suture adjustments were done for any patients during post-operative period.

2.1 Surgical Technique

General anesthesia was used in all operations. Each patient was prepared by cleaning the eyelids with povidone iodine, draping, and insertion of lid speculum. Then a radial suture marker with gentian violet was used to mark the recipient's cornea. Recipient's corneas were excised using the Hessburg-Barron vacuum trephines at a diameter of 7.25 or 7.50 mm. Trephine size was determined according to white to white corneal diameter. Donor corneas were prepared with the Barron donor punch (Katena products) from the endothelial side 0.25 mm oversized. Donor buttons were sutured into recipient by using single running technique, which consisted of 16 bites of 10-0 nylon suture. Gentamycin and dexametasone phosphate were injected subconjunctivally, at the end of the procedure. Topical ofloxacin and prednisolone acetate 0.1% eyedrops were administered 8 times daily postoperatively. Ofloxacin was stopped after 3 weeks, prednisolone acetate was tapered over 12 weeks and continued only one drop a day until 12 months. In the presence of epithelial defect, dosing of topical steroid was reduced.

Sutures were removed at 12 months in all cases. Preoperatively and one month after suture removal (13 months), each patient underwent Pentacam (Oculus,Wetzlar,Germany) Scheimflug topographic examination. The mean anterior and posterior corneal curvatures (central 3mm mean K values), anterior chamber depth (ACD), anterior chamber volume (ACV) and anterior chamber angle (ACA) and central pachymetric readings were recorded.

2.2 Statistical Analyses

Statistical analyses were performed using the SPSS software version 15. The variables were investigated using analytical methods (Shapiro-Wilk test) to determine whether or not they are normally distributed. Descriptive analyses were presented using means and standard deviations

for normally distributed variables (anterior and posterior corneal curvatures, ACD, ACV, ACA and central pachymetric readings). Paired t-test was used to compare the measurements at two time points (preoperatively and 13 months postoperatively). A *P*-value of less than 0.05 was considered to show a statistically significant result.

3. RESULTS

This study included 38 eyes of 38 patients (18 men and 20 women). Mean age of patients was 31.07±13.20 (15-59) years. The mean spherical equivalent was +4.23 ± 3.44 diopters, 13 months post-operatively.

Preoperatively and one month after suture removal (13 months), Pentacam scheimflug imaging was performed. Mean anterior K reading of the cornea changed from 67.73±14.91 D before surgery to 40.40±8.74 D at 13 months. (paired t-test, *P*=.0001).

Mean posterior K reading of the cornea diminished significantly from – 10.82±2.37 D preoperatively to – 5.72±1.65 D at 13 months (*P*=.0001).

Anterior chamber volume decreased from 209.92±40.20 µl preoperatively to 176.00±60.57 µl at 13 months (*P*=.002).

Anterior chamber depth decreased 4.28± 0.61 mm preoperatively to 2.84±0.74 mm at 13 months. (*P*=.0001). Anterior chamber angle decreased from 39.42±8.32 preoperatively to 25.35±14.42 at 13 months.(*P*=.001)

Central pachymetric readings increased from 330.32±87.96 µm preoperatively to 505.03±59.20 µm at 13 months (paired t-test, *P*=.001). Table 1 shows the changes of anterior and posterior corneal curvature, anterior chamber parameters and central pachymetry, preoperatively and one month after suture removal in all operated eyes.

4. DISCUSSION

The development of corneal ectasia which causes irregular astigmatism is the main reason of visual impairment in keratokonus patients, but in advanced stages of disease, corneal scarring may contribute substantially [3]. When hard contact lenses fail to provide satisfactory visual function, and when patients are contact lens-intolerant, surgery becomes the only option to restore adequate vision.

Keratoconus represents low risk keratoplasty and patients usually are young and free of other ocular pathologic features. A large number of studies have shown that penetrating keratoplasty (PK) surgery performed in keratoconus patients, usually leads satisfactory results [7-10].

In this study we evaluated the influence of penetrating keratoplasty on corneal curvature and the anterior chamber parameters with the Pentacam rotating Scheimpflug camera. We found that the mean value of anterior and posterior keratometric readings flattened significantly at 13 months after PK.

The size of the donor and recipient trephines, graft oversize, suture techniques, suture tension and variations in wound construction might be important predictors of corneal curvature after PK [8]. Severity of the disease is also important, where extensive thinning of the mid- to peripheral cornea influences postoperative curvature [11,12].

Table 1. Comparison of anterior chamber measurements of thirty-eight patients who underwent penetrating keratoplasty

Curvatures of cornea, pachymetry and anterior chamber measurements	Time points of measurements		P
	Preoperatively	13 months postoperatively	
Anterior Km	67.73±14.91	40.40±8.74	0.0001*
Posterior Km	-10.82±2.37	-5.72±1.65	0.0001*
ACD	4.28±0.61	2.84±0.74	0.0001*
ACV	209.92±40.20	176.00±60.57	0.002*
ACA	39.42±8.32	25.35±14.42	0.001*
Central pachymetry	330.32±87.96	505.03±59.20	0.0001*

Km mean curvature power of the cornea within the central 3 mm expressed in diopters.
ACD, Anterior Chamber Depth; ACV, Anterior Chamber Volume; ACA, Anterior Chamber Angle.
**Statistically significant difference. Paired t- test*

Because suture removal after PK may dramatically modify the corneal topographic pattern and shape, the main outcome measures were recorded one month after suture removal. In our case series mean corneal curvature was 40.40±6.88 D one month after suture removal (postoperative 13 months). Surgical tecnique was the same (0.25 mm graft over sized, single running suture by a single surgeon) in all patients. We found markedly lower values in corneal curvature than those reported by Kim et al. [7]. They used 0.25 mm over sized donor button and reported mean anterior corneal curvature as 45.01±3.80 D at 12 months after PK. This may be in part due to our suturing tecnique with over-tension, necessary for water-tight wound closure because of the thinner peripheral cornea in keratoconus.

However, lower corneal curvature power in early postoperative period like in our case series may be advantageous for expected development of myopic shift and recurrent keratoconus after keratoplasty [5,6]. A continued natural progression of keratoconus in the host rim may induce thinning of both the host and donor stroma at the graft-host interface leading to wound slippage and progressive keratometric steepening and astigmatism [13]. The healing centrifugal forces in a 0.25 mm oversized graft may be higher than in a 0.50 mm oversized graft. In the present study all grafts were 0.25 mm oversized. So our flatter K readings could be explained by the small (0.25 mm) oversized graft. On the other hand, recurrence of ectasia or keratoconus-like characteristics after PK for keratoconus has been reported in several studies [14-16]. There is evidence that host keratocytes replace donor keratocytes after PK and some investigators have postulated that graft repopulation by recipient keratocytes is responsible for recurrent keratoconus characteristics [16]. Raecker et al. found that, beyond 10 years following surgery, corneal steepening and astigmatism progressively increased in keratoconus patients [17].

We found that, after penetrating keratoplasty, anterior chamber depth, anterior chamber volume and angle were decreased significantly. Because PK is an open-system surgery, it results in a shallower anterior chamber depth and more flattened cornea as a result of collapse of the anterior chamber angle. Kim et al. compared refractive changes occuring after lamellar keratoplasty or PK in patients with keratoconus. They reported lower values for corneal curvature, anterior chamber volume, anterior chamber depth and anterior chamber angle in PK group [7].

Recognition of shift of corneal curvature and anterior chamber parameters in postoperative period may be important. It should be taken into account especially when cataract surgery is to be performed at the time of PK (Triple Procedure) [18]. Ocular biometric data used in IOL power calculation formulas include axial length, corneal curvature and anterior chamber depth and there is a difficulty in IOL power calculations in these cases [19].

5. CONCLUSION

In conclusion; due to a shallower ACD, and a more flattened cornea, hyperopic shift (mean spherical equivalent; +4.23 ±3.44 diopters) was seen 13 months after PK surgery in our study. However, flat corneal curvature may be advantageous for these patients because of delayed and progressive corneal steepening and recurences of keratoconus after keratoplasty. In addition, prediction of corneal curvature and anterior chamber parameters might be useful especially for IOL power calculations in Triple Procedures.

ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments. Our study is a retrospective study. For this type of study formal consent is not required.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Nielsen K, Hjortdal J, Aagaard Nohr E, Ehlers N. Incidence and prevalence of keratoconus in Denmark. Acta Ophthalmol Scand. 2007;85(8):890-892.
2. Jonas JB, Nangia V, Matin A, Kulkarni M, Bhojwani K. Prevalence and associations of keratoconus in rural maharashtra in central India: The central India eye and medical study. Am J Ophthalmol. 2009;148(5):760-765.

3. Romero-Jiménez M, Santodomingo-Rubido J, Wolffsohn JS. Keratoconus: A review. Cont Lens Anterior Eye. 2010; 33(4):157-166.
4. Paranhos JFS, Paranhos A, Avıla MP, Schor P. Analysis of the correlation between ophthalmic examination and quality of life outcomes following intracorneal ring segment implantion for keratokonus. Arq Bras Ophthalmol. 2011; 74(6):410-413.
5. Pramanik S, Musch DC, Sutphin JE, Farjo AA. Extended long-term outcomes of penetrating keratoplasty for keratoconus. Ophthalmology. 2006;113:1633-1638.
6. Choi JA, Lee MA, Kim MS. Long-term outcomes of penetrating keratoplasty in keratoconus: Analysis of the factors associated with final visual acuities. Int J Ophthalmol. 2014;7(3):517-521.
7. Kim KH, Choi SH, Ahn K, Chung ES, Chung TY. Comparison of refractive changes after deep anterior lamellar keratoplasty and penetrating keratoplasty for keratoconus. Jpn J Ophthalmol. 2011; 55:93-97.
8. Borderie VM, Georgeon C, Borderie M, Bouheraoua N, Touzeau O, Laroche L. Corneal radius of curvature after anterior lamellar versus penetrating keratoplasty. Graefes Arch Clin Exp Ophthalmol. 2014; 252:449-456.
9. Choi Jin A, Min AL, Man-Soo K. Long-term outcomes of penetrating keratoplasty in keratoconus: Analysis of the factors associated with final visual acuities. Int J Ophthalmol. 2014;7(3):514-521.
10. Fukuoka S, Honda N, Ono K, Mimura T, Usui T, Amano S. Extended long-term results of penetrating keratoplasty for keratoconus. Cornea. 2010;29(5):528-530.
11. Shimmura S, Ando M, Ishioka M, Shimazaki J, Tsubota K. Same-size donor corneas for myopic keratoconus. Cornea. 2004;23:345-349.
12. Seitz B, Langenbucher A, Szentmary N, Naumann GOH. Corneal curvature after penetrating keratoplasty before and after suture removal: A comparison between keratoconus and Fuch's dystrophy. Ophthalmologica. 2006;220:302-306.
13. Al-Mohaimeed MM. Penetrating keratoplasty for keratoconus: Visual and graft survival outcomes. Int J Health Sci. 2013;7(1):67-74.
14. Barbara R, Barbara A. Recurrent keratoconus. Int J Kerat Ect Cor Dis. 2013;2(2):65-68.
15. Bergmanson JP, Goosey JD, Patel CK, Mathew JH. Recurrence or re-emerge of keratoconus- what is the evidence telling us? Literature review and two case reports. Ocul Surf. 2014;12(4):267-272.
16. Bourges JL, Savoldelli M, Dighiero P, Assouline M, Pouliquen Y, BenEzra D, et al. Recurrence of keratoconus characteristics: A clinical and histologic follow-up analysis of donor grafts. Ophthalmology. 2003;110(10):1920-1925.
17. Raecker ME, Erie JC, Bourne WM. Long-term keratometric changes after penetrating keratoplasty for keratoconus and fuchs endothelial dystrophy. Am J Ophthalmol. 2009;147(2):227-233.
18. Javadi MA, Feizi S, Moein HR. Simultaneous penetrating keratoplasty and cataract surgery. J Ophthalmic Vis Res. 2013;8(1):39-46.
19. Wang JK, Chang SW. Optical biometry intraocular lens power calculation using different formulas in patients with different axial lengths. Int J Ophthalmol. 2013; 6(2):150-154.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/16516