A comparison of the effect of donor-recipient trephine size disparity on refractive error in keratoconus

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ABSTRACT

Objective: To compare the effect of donor-recipient trephine-size disparity on spherical equivalent, and visual outcomes in penetrating keratoplasty for keratoconus.

Methods: A prospective randomized clinical study conducted between April 2000 and April 2004 in the Ophthalmology Department, Shaheed Sadoughi Hospital, Yazd, Iran. Forty patients with keratoconus were randomly assigned to 2 groups. In group I (n=20) the patients were operated on with under-sized blade (0.25 mm disparity[D]), and in group II (n=20) with over-sized (0.50 mm D) trephine.

Results: The spherical equivalent in group I was -2.61±2.81D, and -3.92±3.21D in group II. We found a better final visual acuity in group I compared with group II. More myopic shift was observed in group II, with greater disparity. Best-corrected visual acuity (BCVA) was better at the final follow-up in group I, compared with group II. Fourteen patients (70%) achieved BCVA 20/40 or better in group I, whereas in group II only 10 patients (5.0%) achieved this vision. Mean keratometry was 44.35D in group I, and 45.05D in group II.

Conclusion: We conclude that using donor-recipient under-sized trephine (0.25mm D) can be considered a reliable and effective method in reducing postoperative myopia.

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Keratoconus is a non-inflammatory, bilateral, and progressive ectasia of cornea, with a prevalence rate of 1/2000 per populations.[1,2] Keratoconus is one of the most common indications for corneal transplantation in Iran, and other parts of the world.[3-7] When contact lens use is not possible due to a large cone, advanced keratoconus or corneal opacities penetrating keratoplasty must be performed.[8,9] Successful surgery and graft survival in keratoconus is high, and this is due to low graft rejection.[10] Corneal graft in keratoconus is successful when it leads to the lowest incidence of postoperative astigmatism and myopia.[11] Penetrating keratoplasty for keratoconus provides good visual results in most cases so that the postoperative Best-corrected visual acuity (BCVA) is usually 20/40 or better. Factors reported to affect the amount of myopia and astigmatism after penetrating keratoplasty (PK) include severity of the disorder, trephination method, donor-recipient disparity, and suturing technique.[12-14] The donor-recipient size disparity has an effective role on post-operative refractive error.[15-17] Other studies indicated that over-sized corneal graft for keratoconus causes more myopia and steeping of the cornea.[18,19] The use of under-sized or same-sized grafts to compensate for myopia tendency has been recommended.[16,17] Our experience, based on clinical evaluation, showed that over-sized buttons caused greater myopia and corneal steepness after keratoplasty. To prevent postoperative myopia, it is better to minimize the difference in size between the recipient and donor cornea as much as possible, even the same-size buttons can be used. The current study was conducted to determine the effect of donor-recipient disparity (0.25 versus 0.50 mm) on final visual outcomes of PK, for keratoconus.

Methods. We studied 40 keratoplasties performed on keratoconic eyes between April 2000 and April 2004. This study was a single center, randomized clinical trial at the Department of Ophthalmology, Shaheed Sadoughi Hospital, Yazd, Iran. Patients included

in the study were aged 15-45, no previous eye operation, no eye disease, and with BCVA of 20/80 or worse. Patients with vernal keratoconjuctivitis background, associated systemic diseases, and pellucid marginal degeneration, were excluded from the study. A total of 40 consecutive eyes planned for PK were screened. Eligible patients were randomly assigned to one of the 2 groups. In the first group, (n=20) the donor's cornea was 0.25 mm larger than the recipient (under-sized). In the second group (n=20), it was 0.50 mm larger (over-sized). A written informed consent was obtained from each individual before the operation. The research protocol had the local Ethical committee approval.

The analyzed data includes age, sex, keratometry results, pre- and postoperative visual acuity, recipient-donor trephine-size disparity, suture removing time, and final visual outcome. Visual acuity was shown in logarithmic minimum angle of resolution (logMAR). All operations were performed by the same corneal surgeon, with the same technique, and under general anesthesia. All donor corneas were preserved as a cornea scleral button in optisol solution at 4°C, and were obtained from the Central Eye Bank of the Islamic Republic of Iran. The donor's cornea was punched with Hessburg Barron trephine (Katena Products Inc, Benville, NJ, USA) on the endothelial side. Host corneas were cut with Hessburg-Barron (Katena Porducts INc., Benville, NJ, USA) suction trephine. The recipient bed diameter ranged from 7.00-8.25 mm, and this was based on vertical corneal diameter. For a 10.5 mm vertical diameter and more, 8 mm trephine was used; for less than 10 mm diameter, 7.5 mm trephine and for a diameter between 10-10.5 mm, a 7.75 mm trephine was used (**Table 1**). Donor buttons were 0.25 and 0.50 mm larger than the recipient corneas. The donor's cornea was placed on recipient eye, and sutured with 4 cardinal sutures. Suturing was completed with interrupted technique (16 separate sutures), with 10-0 nylon. To control astigmatism during surgery, Maloney keratoscope (Jedmed Instrument Co., USA) was used. At the end of surgery, gentamicin 20 mg and betamethasone 4 mg were injected subconjunctivally. Topical corticosteroids and antibiotics were administered in tapering dosage after surgery. The topical antibiotics were discontinued after one month but the topical steroid was continued for at least the first 3 months. Patients were visited on postoperative days 1, 2, and 3, then every week for the first month, and monthly for 18 months. Sutures were removed between 9-18 months postoperatively. Suture removal was performed with corneal topography guided control. In the cases that keratometric astigmatism was higher than 6D, selective suture removal was carried out at steep axis between 4-8 months, but loose sutures causing corneal vascularization were removed earlier. Six weeks after suture removal, refraction and keratometry were performed. A BCVA of 20/40 (0.3 logMAR) or more was considered as good vision. Patients were followed for a mean period of 22.4 months.

Student t test was used for comparison of 2 independent continuous variables. The paired t test employed to compare pre- and postoperative values.

Results. There were 12 (30%) males and 8 (20%) females in group I, with the mean age of 23.5±4.7 years. In group II, there were 13 (32.5%) males and 7 (17.5%) females with the mean age of 24.5±4.7 (16-41) years. The majority of cases (25 patients; 62.5%) were male. Overall, 24 (60%) right and 16 (40%) left eyes were included in this study. Mean postoperative keratometry in group I were 44.35Disparity (D), and 45.05D in group II. For both groups, the surgery resulted in significant reduction of keratometric readings at 12 and 18 months postoperatively. Indications for corneal graft in keratoconus are presented in **Table 1**. Preoperative keratometry was 50-59D in 18 eyes (45%), and ≥60D in 15 eyes (37.5%). Keratometry could not be obtained in 7 eyes (7.5%) due to corneal scar or advanced keratoconus. Visual and refractive outcomes for the 2 levels of disparity are presented in **Table 2**. The mean pre-operative uncorrected visual acuity (UCVA) was 1.05±0.48 logMAR, and mean preoperative BCVA was 0.9±0.26 (3-0.8) logMAR. The mean BCVA at final follow-up was 0.26±0.14 logMAR (range from 0.2-1.4). Eighteen months after the operation, 14 eyes (70%) achieved BCVA of 20/40 or better in group I, whereas only 10 eyes (50%) achieved this vision in group II. Patients in group I achieved a better visual outcome compared with group II. This difference was not statistically significant at the end of 12 months (p=0.36). The difference, however, became significant at the end of 18 months (p=0.001). The parameters studied through these 2 surgical techniques at the end of 12 and 18 months are shown in **Table 2**. At the end of 12 months, the mean postoperative refractive error (spherical equivalent [SE]) in group I was lower than that of group II (-2.61±2.8D *versus* 3.92±3.21D), and the difference was significant (p=0.023). The reduction in mean postoperative refractive error SE at the end of 18 months was statistically significant (p=0.01). The SE and astigmatism, gradually and progressively improved at 18 months. Although the amount of cylinder was not significantly different between these 2 groups at the end of 12 (p=0.45), and 18 months (p=0.46), there was a trend toward greater myopic shift SE in cases with 0.50 mmD. After suture removal, the mean keratometry have increased and myopia shift was found, whereas there was a decrease in astigmatism.

Discussion. Post-keratoplasty myopia and high astigmatism are the common causes of postoperative

poor vision in spite of graft transparency.[20] Numerous studies have been carried out to evaluate the causes, and did suggest the methods of reducing refractive error.[21-23] Previous studies showed that in keratoconus over-sized donor cornea induces greater myopia.[18,19] Although over-sized grafts make surgical procedure easier and reduce the risk of postoperative glaucoma, it induces more steepening of cornea.[19,23] Reduction of donor-recipient trephine disparity to 0.25 mm, or using same-sized grafts will reduce postoperative refractive error. In the current study, 62.5% of patients were male, that was similar with other studies.[24-26] Our study demonstrates that the most common indication for PK was BCVA of less than 20/80 with hard lens due to corneal scar, and advanced cone as shown in Javadi et al[29] study. This was in contrast to contact lens intolerance in most studies.[8,25] Heidemann et al,[19] in a study on 73 patients grafted with same-size or 0.50 mm over-size cornea showed that postoperative corneal curvature is greater in over-sized group. The same result has been reported by Perry and Foulks[18] in keratoconus patients. They believe that spherical refractive error and mean keratometry in under-sized group is remarkably less, compared with 0.5 mm over-sized group. Wilson and Bourne[22] has studied same-sized grafts and grafts with 0.25 mm disparity, and the results indicate that same-sized group suffers less myopia. Our study was in agreement with above studies in this field. Spherical refractive error, corneal astigmatism, and BCVA in this study are comparable with other reports.[17,18,24] In a research performed in Iran by Javadi et al,[24] on patients grafted with 0.25 mmD or 0.5 mmD, it was indicated that SE remained -1.55D and -3.33D, and this difference was significant. This study was in agreement with our study with an SE of -3.1D and -4.2D. Further, mean keratometry was 43.3±1.9D in 0.25 mmD, and 44.8±1.60D in 0.5 mmD,[24] which is similar to what we found in our study (**Table 3**). Nikkhou et al[25] showed that in under-sized graft (0.25 mmD), the SE was closer to ametropia than the graft with 0.50 mmD (-1.1D versus -2.5D). Olson et al[26] showed the results of a corneal graft in 2 groups of aphakic patients, one with 0.50 mmD and the other with same-sized graft, and showed that the donor-recipient trephine-size disparity has no effect on final refractive error. This result was different from our study and from the others, perhaps due to aphakic feature of their patients. Goble et al[16] has also reported 49 cases of same-sized corneal graft in keratoconus. Their postoperative mean SE was 0.75D. Doyle et al[23] studied 2 groups of patients, with same-sized and under-sized corneal graft, in which postoperative refractive error of group I was closer to ametropia. This study suggests using under-sized graft

Table 1 - Indications for penetrating keratoplasty in keratoconus.

Indications	n (%)
Corneal scar	20 (50)
BSVA ≤20.80, with hard lens	14 (35)
Hard lens intolerability	6 (15)
Total	40 (100)

BCVA - best-corrected visual acuity.

Table 3 - Post-suture removal keratometry in 2 groups.

Keratometry (Diopter)	Group I	Group II
40-41	-	1
41-42	3	0
42-43	3	1
43-44	3	3
44-45	4	3
45-46	3	6
46-47	3	4
47-48	2	2
Total	20	20

Table 2 - Visual and refractive outcomes of penetrating keratoplasty in 2 groups, after 12 and 18 months.

Recipient-Donor disparity	BCVA (logMAR)	Sphere	Cylinder	SE
		(Mean ± SD)		
After 12 months				
0.20.5 mm	0.12±0.07	-1.65±2.2	3.1±1.6	-3.1±2.5
5 mm	0.16±2.2	-3.1±2.5	3.9±2.8	-4.2±2.8
p value	0.36	0.005	0.45	0.023
After 18 months				
0.20.5 mm	0.11±0.05	0.5±2.3	2.1±2.5	-1.9±1.8
5 mm	0.14±0.08	-1.7±2.53	4.4±2.6	-3.2±2.15
p value	0.001	0.002	0.46	0.01

BCVA - best-corrected visual acuity, LogMAR - logarithmic minimum angle of resolution, SE - spherical equivalent.

for the anterior- posterior-vitreous length of less than 15.5 mm and same-sized trephine with length of more than 15.5 mm. In Duran et al[20] study, in which 24 keratoconus patients underwent corneal graft, better visual outcomes were obtained with same-sized group than 0.5 mm over-sized. In another study performed on 3 groups by Domingo Gordo et al,[27] it was concluded that final visual acuity is better in same-sized group than in 0.25 mm over-sized group, and finally in group with 0.5 mmD. Their SE has also increased. Shimmura et al[28] in a study of 142 keratoconus used same-sized donor for eyes with axial length longer than 24.50 mm, whereas a 0.25 mm-oversized donor was used for eyes shorter than 24.49 mm. This study showed that using same-sized donor grafts in keratoconus patients with long visual axis is a safe, and effective method in reducing postoperative myopia. Spadea et al[15] has also reported results of same-sized recipient-donor trephines, and reported postoperative mean SE of -1.50D. This study like ours, indicated less myopia and better visual outcome in same-sized grafts, or grafts with at least 0.25 mmD. Girard et al[17] operated on 15 keratoconus patients using 0.25 mm under-sized grafts, and reported that SE were reduced from -15.38D before the operation to -2.17 post operation. In our study, donor-recipient disparity had no effect on astigmatism, 0.25 mmD and 0.50 mmD were comparable at final follow-up, that is consistent with previous reports.[24,25,29] Javadi et al[29] recent study showed that suturing technique and severity of keratoconus have no effect on visual outcome after grafting, and the main factor in reducing postoperative myopia can be a minimum disparity of donor-recipient trephine size.

We conclude that using donor-recipient under-sized trephine (0.25 mmD) can be a reliable and an effective methods in reducing postoperative myopia, and achieving successful graft. However, there is a need for further studies with which to refine decision-making with regards to the choice of donor-recipient disparity in PK.

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