

Outcomes of Penetrating Keratoplasty in Patients with Macular Corneal Dystrophy

Abstract

Purpose: To describe the results of the penetrating keratoplasty (PKP) in patients with macular corneal dystrophy (MCD).

Methods: In this descriptive study, patients transplanted for MCD from 1986 to 2006 were recalled and enrolled in the study provided that at least 6 months had elapsed from the date of the transplantation. The main outcome measures were the gain in visual acuity, postoperative astigmatism and graft survival.

Results: Sixty-two eyes of 39 patients were included in the study. At the time of the keratoplasty, the age of the patients averaged 34 ± 10.5 (range, 13 to 58) years. After PKP, the patients were followed for 52 ± 47.3 months, on average (range, 6 to 190 months). At baseline, mean best spectacle corrected visual acuity (BSCVA) was 1.4 ± 0.4 LogMAR (4/100) that increased to 0.2 ± 0.32 LogMAR (20/32) after PKP ($P < 0.0001$). Comparing suturing techniques, there was no statistically significant difference between separate, continuous, and combined techniques regarding final postoperative astigmatism ($P = 0.9$). In 36 eyes operated before 35 years of age, mean BSCVA was 0.15 ± 0.40 LogMAR. It was 0.26 ± 0.25 LogMAR in 26 eyes operated at or older than 35 years ($P = 0.005$). In 12 eyes (19.4%), immunologic graft rejection not leading to graft failure happened during the follow-up. In all patients but one transplanted corneas were clear at the end of the follow-up.

Conclusion: Graft survival is excellent for patients with MCD. PKP in these patients will improve vision significantly and final visual acuity seems to be better if transplantation is performed before 35 years of age.

Introduction

Macular corneal dystrophy (MCD) is the least common one of three classic corneal stromal dystrophies,¹ but constitutes the most common indication for penetrating keratoplasty (PKP) for corneal dystrophies in Iran.² It is an autosomal recessive disorder but can occur without any family history¹ and the reason for high prevalence in this country may be attributable to consanguineous marriage which is still common in rural areas. This dystrophy begins earlier than granular and lattice corneal dystrophies. During the first decade, corneal opacity starts centrally and superficially and then gradually progresses to the posterior and peripheral portion of the cornea.^{1,3} At the end, the entire corneal stroma will become opaque and result in visual acuity reduction and finally blindness.^{1,3} Between 20 and 30 years of age, corneal transplantation will be indicated due to severe visual acuity reduction.³ Its superficial form may be treated by superficial keratectomy or phototherapeutic keratectomy⁴ but in advanced cases, definite treatment is penetrating keratoplasty (PKP).⁵ Recurrence of MCD in transplanted cornea is rare but it may happen lately.⁵ Therefore, the prognosis of the corneal transplantation in this dystrophy is better than others.⁶

Herein, we report the results of the corneal transplantation in patients with MCD between 1986 and 2006 in Labbafinejad hospital, as a tertiary referral center.

Materials and methods

In this descriptive case series, 71 eyes from 45 patients with MCD that had undergone PKP between 1986 and 2006 were evaluated. Their medical records were extracted through computerized filing system based on international coding of disease (ICD-10). Patients were recalled for new ocular examination. The data of the patients, who participated and remained in the study for at least 6 months, were considered for analysis. But, patients who had inadequate information or could not attend follow-up examination were excluded. MCD was diagnosed based on clinical findings as described in previous studies.^{3,4,7,8}

Preoperative examinations consisted of visual acuity, refractive error and slit-lamp examination. The data of the last examination including uncorrected visual acuity (UCVA), best spectacle corrected visual acuity (BSCVA), refractive error, intra-ocular pressure (IOP), graft clarity, any episode of endothelial graft rejection during the follow-up, graft failure and recurrence of MCD in the transplanted cornea were compiled. Also, operation data such as the size of the trephination of the recipient cornea, donor-recipient disparity, suturing technique and intraoperative complications were recorded.

PKP was performed in all cases under general anesthesia using a Hessburg Barron (Katena Products, inc. 4 Stewart Court, Denville, New Jersey, USA) suction trephine. Circular trephine blades (Storz Ophthalmics, St Louis, Missouri, USA) ranging from 7.5 mm to 8.5 mm in diameter were used to punch the donor lenticule from the endothelial side of the corneoscleral button. In all cases, the host graft disparity was kept at 0.5 mm with donor graft being larger than the host. The donor lenticule was secured to the

recipient corneal rim with 10-0 monofilament nylon sutures. The suturing techniques consisted of interrupted (16 separate sutures), single running (with 16 bites), and combined (8 separate sutures and a 16-bite running suture). Preoperatively, intravenous mannitol 20%, 1 to 2 mg/kg, was administered to lower IOP during the operation. At the end of the operation, subconjunctival gentamicin 20 mg and betamethasone 4 mg were injected. Postoperatively, the patients were medicated with topical betamethasone 0.1% and sulfacetamide 10% eye drops four times a day. Antibiotic eyedrop was discontinued after 5 to 7 days and betamethasone eyedrop was gradually tapered over 4 months. Selective suture removal was performed for any suture-related problems and for control of astigmatism, based on topography, from four month onward. Suture removal was completed between 12 and 18 months after the date of the surgery. Patients were examined on 1st, 2nd, 3rd and 7th days and then every week up to one month, every 2 weeks up to 2 months, monthly up to 4 months, and every 2 months thereafter. Finally, two months after complete suture removal, patients were reevaluated. The mean follow-up period was 52±47.3 (range, 6 to 190) months.

Graft survival was considered as the duration of the clarity of the graft or the elapsed time between the first and second graft.

SPSS 11 was used to analyze the compiled data and overall graft survival was assessed by Kaplan-Meier method.⁹

Results

Between 1986 and 2006, 71 eyes from 45 patients with MCD underwent PKP. Of whom, 62 eyes from 39 patients had complete follow-up so enrolled for statistical analysis. Twenty-nine (47.8%) were right eye and 33 (53%) were left. Fifteen (38.5%) patients were female and the rest (61.5%) male. In 27 (70%) patients, at least one relative was affected by MCD and in 12 (30%) patients, family history was negative. Table-1 demonstrates demographic and preoperative data.

Table-1: Preoperative demographic data of the patients with MCD at the time of surgery

	Mean±SD	Range
Patients' age (years)	34±10.5	13 to 58
Follow-up (months)	52±47.3	6 to 190
BSCVA (logMAR)	1.4±0.4 (4/100)	2/1000 to 2/100
IOP (mmHg)	12.3±2.6	8 to 20

BSCVA: best spectacle corrected visual acuity, IOP: intra-ocular pressure.

Thirty-six (93%) patients presented with low visual acuity, but 2 (5%) cases complained of reduced visual acuity associated with photophobia and 1 further case suffered from photophobia with ocular pain. All the patients were explained about the advantages and disadvantages of PKP and informed consents were signed. Table-2 shows the results of the final examination.

Table-2: The data of the final examination in cases of MCD at least 6 months after PKP

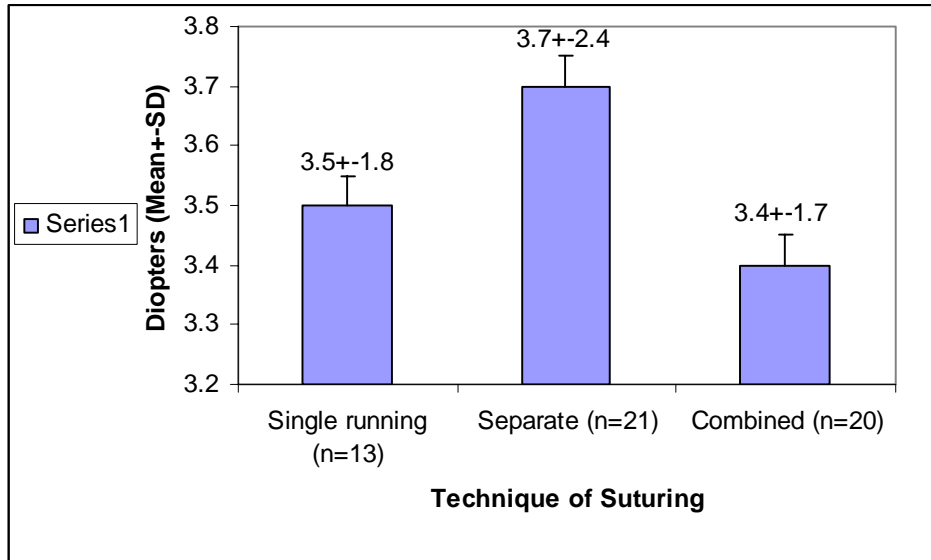
	Mean±SD	Range
UCVA (logMAR)	0.6±0.44 (20/80)	2/100 to 20/25
BSCVA (logMAR)	0.2±0.32(20/32)	32/100 to 20/16
SE (diopters)	-2.25±3.25	-10.75 to +5.75
Refractive astigmatism (diopters)	3.4±2.0	0.0 to 9.0
Keratometric astigmatism (diopters)	4.0±2.7	0.0 to 12.0
Central Keratometry (diopters)	45.5±3.3	39.0 to 56.25
IOP (mmHg)	13.3±3	6 to 20

UCVA: uncorrected visual acuity, BSCVA: best spectacle corrected visual acuity, SE: spherical equivalent, IOP: intra-ocular pressure.

After corneal transplantation, improvement in visual acuity was statistically significant ($P<0.0001$). In terms of IOP, there was no statistically significant difference before and after the corneal transplantation. ($P=0.1$).

Suturing technique in 54 eyes for which data were available was single running, separate or combined. With respect to refractive or keratometric astigmatism, different suturing techniques yielded the same results ($P=0.9$). Figure-1 shows postoperative mean refractive astigmatism in different suturing techniques.

Figure-1: Results of different kinds of the suturing technique for PKP in MCD cases



Mean postoperative BSCVA in 36 eyes of patients younger than 35 years was 0.15 ± 0.40 logMAR and of those older than 35 years (26 eyes) was 0.26 ± 0.25 logMAR which was significantly lower than the first group ($P=0.005$). Comparing these two groups, patient's age at the time of operation had no effect on refractive astigmatism, keratometric astigmatism, mean KR and spherical equivalent (SE) ($P=0.24$, $P=0.26$, $P=0.25$, and $P=0.69$, respectively).

During the follow-up, 12 (19.4%) eyes had immunologic graft rejection. In 6 (50%) eyes, the first episode of the graft rejection was endothelial type, in 3 (25%), it was subepithelial infiltration type and the remainder had combination of endothelial and subepithelial graft rejection. In 8 (66.7%) eyes, graft rejection happened once, in 1 (8.3%) eye, it occurred twice and in other 3 (25%) eyes, it happened 4 times. All of them were

rescued by either topical or topical and systemic corticosteroid therapy. Elapsed time between operation and first rejection episode was 6.1 ± 3.5 months, on average (range, 2 to 14 months). There was no correlation between patients' age and occurrence of graft rejection ($P=0.33$).

All but one (98.4%) transplanted corneas remained clear at the end of the follow-up. In one eye (1.6%), 10 years after corneal transplantation, traumatic graft dehiscence and cataract occurred. Graft resuturing and cataract extraction and intraocular lens implantation were performed but after a while, the graft failed. Four eyes underwent keratorefractive surgery for intolerable high amount of astigmatism. In 2 (5.1%) patients, MCD was associated with keratoconus which were previously reported by us.¹⁰

One eye underwent scleral buckling with deep vitrectomy for retinal detachment. In other 2 eyes, barrier laser of retina was done for peripheral retinal degeneration. In three eyes, cataract extraction and intraocular lens implantation was done at the time of PKP.

Discussion

MCD is one of the three classic stromal dystrophies with own features. For example, because of collagen fiber compaction, central corneal is thin¹. Despite autosomal recessive inheritance, high prevalence of MCD in Iran can be explained by consanguineous marriage. In Kanavi et al study², reporting indications for PKP in Iran over 10 years, corneal dystrophies ranked forth after keratoconus, corneal opacity and scar, and pseudophakic bullous keratopathy. Among corneal dystrophies, MCD was the

most common indication for PKP accounting for 3.14% of all PKP performed in this country at that period.

Recurrence of MCD in transplanted cornea is rare. According to studies conducted by Marcon et al.¹¹ between 1984 and 2001, there was no recurrence in transplanted corneas of patients with MCD. Meyer⁶ followed up 14 transplanted eyes of patients with MCD for 22 years and reported 2 recurrences. He concluded that MCD has better prognosis than granular and lattice corneal dystrophies and patients' visual acuity remains stable for long time. Akora et al.⁸ reported 2 recurrences out of 6 corneal transplantations and Klintworth et al.¹² reported 2 recurrences 18 and 19 years after PKP and lamellar keratoplasty (LKP), respectively. Our findings that show no recurrence of MCD in transplanted corneas up to 190 months after surgery are in accordance with these studies.

In current study, all grafts but one (that suffered from trauma) was clear at the end of the study. According to Vail et al.,¹³ who studied 2358 corneal grafts, corneal stromal dystrophies ranked second after keratoconus with respect to graft clarity. Factors that worsened the prognosis of the graft in that report are operation before 10 years of age, deep vascularization, and non-optical indications of transplantation. These factors are not present in MCD which explains excellent result of PKP as it was a case in our study.

In current study, preoperative mean UCVA of 1.4 logMAR (4/100) became 0.6 logMAR (20/80) after operation and BSCVA improved to 0.2 logMAR (20/32). Generally, it seems that prognosis of final vision in transplanted patients with MCD is as excellent as other avascular corneal dystrophies such as keratoconus.¹⁴

In our study, SE after corneal transplantation was -2.25 ± 3.25 D, on average (range,

-10.75 D to +5.75 D). There is no similar study on MCD to compare postoperative SE with, but considering studies that dealt with other types of dystrophies such as Lim study¹⁴ in which mean SE after PKP in keratoconic patients was -0.33 D, the amount of myopia in our study was much higher. It can be attributable to ample host-donor disparity of 0.5 mm used in our cases. Such amount of disparity would result in increasing anterior-posterior diameter of eyes confirmed in some eyes by A-scan ultrasonography, but further study in this field is required to address this issue.

In Lim study,¹⁴ factors such as age, sex, donor age, donor size, suturing technique, amount of astigmatism before the operation and at the time of suture removal had no effect on final astigmatism at all as it was a case in our study. It seems aforementioned factors have no influence on final astigmatism and visual acuity provided that suture adjustment and selective suture removal based on topography are performed adequately.

Because this dystrophy is progressive in second and third decades of life and there is no risk for amblyopia, final visual outcome is good. In our study, in patients younger than 35 years, visual acuity was significantly better than older ones. One reason for lower vision among the elders may be the vitreoretinal changes that progress by aging and have negative impact on final visual acuity. This hypothesis should be evaluated and confirmed through further studies.

Conclusion

Patients with MCD may need corneal transplantation in the fourth decade of life, on average. In these patients, graft survival is excellent. Disease recurrence has been rare in

spite of long-term follow-up. Improvement in visual acuity after operation is significant. Increased age is associated with reduced visual performance, but does not significantly affect graft survival. Refractive errors after corneal transplantation for MCD are toward myopia that can be due to increased anterior-posterior diameter of the globe. The suturing technique during corneal transplantation had no effect on final astigmatism as long as suture removal is done adequately. Those patients operated earlier than 35 years of age have better BSCVA than the elders.

References

1. Quantock AJ, Meek KM, Ridgway AE, et al. Macular corneal dystrophy: reduction in both corneal thickness and collagen interfibrillar spacing. *Curr Eye Res.* 1990 Apr;9(4):393-398.
2. Kanavi MR, Javadi MA, Sanagoo M. Indications for penetrating keratoplasty in Iran. *Cornea.* 2007 Jun;26(5):561-563.
3. al Faran MF, Tabbara KF. Corneal dystrophies among patients undergoing keratoplasty in Saudi Arabia. *Cornea.* 1991 Jan;10(1):13-16.
4. Wagoner MD, Badr IA. Phototherapeutic keratectomy for macular corneal dystrophy. *J Refract Surg.* 1999 Jul-Aug;15(4):481-484.
5. Kuchle M, Cursiefen C, Fischer DC, et al. Recurrent macular corneal dystrophy type II 49 years after penetrating keratoplasty. *Arch Ophthalmol.* 1999 Apr;117(4):528-531.
6. Meyer HJ. Prognosis of keratoplasty in hereditary stromal dystrophies. *Klin Monatsbl Augenheilkd.* 1996 Jun;208(6):446-449.

7. Lang GK, Naumann GO. The frequency of corneal dystrophies requiring keratoplasty in Europe and the U.S.A. *Cornea*. 1987;6(3):209-211.
8. Akova YA, Kirkness CM, McCartney AC, et al. Recurrent macular corneal dystrophy following penetrating keratoplasty. *Eye*. 1990;4:698-705.
9. Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. *J Am Stat Assoc* 1958;53:475-481.
10. Javadi MA, Rafee'i AB, Kamalian N, et al. Concomitant keratoconus and macular corneal dystrophy. *Cornea*. 2004 Jul;23(5):508-512.
11. Marcon AS, Cohen EJ, Rapuano CJ, et al. Recurrence of corneal stromal dystrophies after penetrating keratoplasty. *Cornea*. 2003 Jan;22(1):19-21.
12. Klintworth GK, Reed J, Stainer GA, et al. Recurrence of macular corneal dystrophy within grafts. *Am J Ophthalmol*. 1983 Jan;95(1):60-72.
13. Vail A, Gore SM, Bradley BA, et al. Corneal graft survival and visual outcome. A multicenter Study. Corneal Transplant Follow-up Study Collaborators. *Ophthalmology*. 1994 Jan;101(1):120-127.
14. Lim L, Pesudovs K, Coster DJ. Penetrating keratoplasty for keratoconus: visual outcome and success. *Ophthalmology*. 2000 Jun;107(6):1125-1131.