Assessment of Preoperative Risk Factors Associated with Trabeculectomy Failure in Patients with Penetrating Keratoplasty

Penetran Keratoplastili Hastalarda Trabekülektomi Başarısızlığında Cerrahi Öncesi Risk Faktörlerinin Değerlendirilmesi

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ABSTRACT

Purpose: To investigate preoperative risk factors for trabeculectomy failure in patients with penetrating keratoplasty (PK).

Materials and Methods: Data of 46 patients (48 eyes) with PK who underwent trabeculectomy for medically uncontrolled elevated intraocular pressure (IOP) were reviewed retrospectively from patient charts.

Results: At post-operative 24 months, trabeculectomy failed to control IOP despite additional anti-glaucomatous medications in 11 eyes (22.9%). IOP was under control with medications in 10 eyes (20.8%) and without medications in 27 eyes (56.3%). Cumulative probability of surgical success was 91.7% at 3 months, 89.6% at 6 months, 82.5% at 9 months, 80.2% at 12 months, and 74.8% at 18 months in the whole sample. Previous graft failure (odds ratio = 9.4, p = 0.009) and initial corneal diseases other than keratoconus/dystrophies (odds ratio = 6.8, p = 0.081) were the most likely associated preoperative risk factors for trabeculectomy failure. Survival rates in eyes with previous corneal graft failure, pseudophakia/aphakia, previous ocular surgery, or initial corneal diseases other than keratoconus/dystrophies were lower than their counterparts (p = 0.004, 0.230, 0.124, and 0.049 respectively). Cumulative probability of surgical success in eyes without these risk factors was 100% at postoperative 24 months, while it was 67.7% in eyes with at least one risk factor (p = 0.054).

Conclusions: Previous graft failure and initial corneal diagnosis are the most likely associated preoperative risk factors with trabeculectomy failure in eyes with PK. Alternative surgical procedures may be considered especially in eyes with a history of previous corneal graft failure.

Key Words: Penetrating keratoplasty, glaucoma, elevated intraocular pressure, trabeculectomy.

ÖZ

Amaç: Penetran keratoplastili (PKP) hastalarda trabekülektomi başarısızlığında cerrahi öncesi risk faktörlerini değerlendirmek.

Gereç ve Yöntem: PKP sonrası medikal tedavi ile kontrol edilemeyen yüksek göz içi basıncı (GİB) nedeniyle trabekülektomi uygulanmış 46 hastanın (48 göz) verileri retrospektif olarak hasta dosyaları üzerinden incelendi.

Bulgular: Trabekülektomi sonrası 24. ayda, 11 gözde (%22.9) trabekülektomi GİB kontrolünde başarısız oldu. GİB, 10 gözde (20.8%) medikal tedavi ile, 27 gözde (56.3%) ise ilaçsız kontrol altındaydı. Tüm çalışma grubunda, cerrahi başarının kümülatif sağkalım olasılığı 3. ayda %91.7, 6. ayda %89.6, 9. ayda %82.5 12. ayda %80.2 ve 18. ayda %74.8 olarak hesaplandı. Daha önce korneal greft yetersizliği (risk oranı = 9.4, p = 0.009) ve ilk korneal hastalığın keratokonus/distrofi dışı nedenler olması (risk oranı = 6.8, p = 0.081) trabekülektomi başarısızlığı ile en çok ilişkili risk faktörleriydi. Daha önce greft yetersizliği olması, psödofaki/afaki, eski göz cerrahisi veya keratokonus/distrofi dışı kornea hastalığı olan gözlerde sağkalım oranları karşıtlarına göre daha düşük bulundu (sırasıyla p = 0.004, 0.230, 0.124 ve 0.049). Cerrahi başarının kümülatif sağkalım olasılığı bu risk faktörlerini içermeyen gözlerde 24. ayda %100 iken, risk faktörlerinden en az birini içerenlerde bu oran %67.7 olarak bulundu (p = 0.054).

Sonuçlar: Daha önceki greft başarısızlığı ve ilk korneal tanı PKP'li hastalarda trabekülektomi başarısızlığı ile en çok ilişkili faktörlerdir. Özellikle daha önce korneal greft reddi hikayesi olan gözlerde alternatif cerrahi prosedürler tedavide düşünülebilir.

Anahtar Kelimeler: Penetran keratoplasti, glokom, yüksek göz içi basıncı, trabekülektomi.

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Geliş Tarihi - Received: 16.03.2018
Kabul Tarihi - Accepted: 23.07.2018
Glo-Kat 2018; 13: 169-176

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INTRODUCTION

Penetrating keratoplasty (PK) is the most commonly performed keratoplasty procedure in the treatment of various corneal diseases.[1] Glaucoma is the leading cause of irreversible vision loss and an important cause of corneal graft failure in eyes with PK.[1,2] Post-PK ocular hypertension is reported to be 11 to 50%.[1] Risk factors for the development of elevated intraocular pressure (IOP) in eyes with PK have been studied extensively in the literature.[1,3-5] Aphakia, pseudophakia, preexisting glaucoma, combined surgery with PK, prolonged steroid use, prior history of uveitis, prior corneal herpetic infection, and corneal re-grafting are reported to be significant risk factors.[1-6] Reliable assessments of optic nerve and visual field are often impossible in eyes with PK (especially in eyes with optic media opacities or with aphakia), therefore discrimination of glaucoma from ocular hypertension is often difficult.[1,2,5]

Management of IOP in eyes with PK is often challenging.[1] Anti-glaucomatous medications (AGMs) are insufficient to control IOP in a significant number of patients. Several laser and surgical procedures, such as trabeculectomy, glaucoma drainage devices and cylodestructive procedures, have been tried in the management of elevated IOP but outcomes of these methods are highly variable in the literature.[1,2] Each procedure has their own advantages and limitations and currently, there is no consensus about the ideal surgical option in eyes with PK.[1]

Surgical method selection is quiet important for long term survival of both optic nerve and corneal graft. The aim of the current study is to investigate the preoperative factors associated with trabeculectomy failure in eyes with PK and to determine the most appropriate patient group for long term trabeculectomy success.

PATIENTS AND METHODS

This study was conducted by the tertiary Glaucoma and Cornea Clinics of Ankara Training and Research Hospital of University of Health Sciences. Data of the patients with PK who underwent trabeculectomy for the management of elevated IOP despite maximal tolerated medical therapy between January 1991 and December 2016 were reviewed retrospectively from patient charts. Patients who had less than 6 months of follow-up after trabeculectomy and who had inadequate data in patient charts were excluded from analysis. Demographic characteristics, surgical procedures, preoperative clinical status, indications for keratoplasty, complications and clinical findings during follow-up were noted. An informed consent was obtained from all patients before each surgical procedure. Institutional review board approval was obtained before the study. The protocol of the study was planned according to the World Glaucoma Association guidelines on the design and reporting of glaucoma surgical trials[7] and adhered to the tenets of Helsinki Declaration.

IOP was measured by Goldmann applanation tonometry and mean value of IOP readings from the steepest and flattest corneal meridians was determined as the IOP value at each visit. Elevated IOP was defined as having an IOP > 21 mmHg. The eyes which underwent more than one PK, last PK before trabeculectomy was selected as the index PK. The eyes which underwent more than one trabeculectomy, the first trabeculectomy after PK was selected as the index trabeculectomy.

Eyes were classified according to trabeculectomy success which was defined as having an IOP >5 Hg and <22 mmHg with (qualified success) or without (complete success) anti-glaucomatous medications and without need for further glaucoma surgery.[7] Revision surgeries, such as needling, anterior chamber formation, suture lysis or re-suturation, and subconjunctival anti-metabolite injection were not defined as failure unless post-surgical IOP was still under control. The study group was also stratified according to risk factors for further analyses.

Surgical method for trabeculectomy

Under local or general anesthesia a fornix-based conjunctiva-Tenon flap was created. Wet-field cautery was performed to episcleral vessels on the planned scleral flap area. For anti-metabolite application 0.2 mg/ml mitomycin-c (MMC) or 50 mg/ml 5-fluorouracil (5-FU) soaked sponges were applied under the conjunctiva for 3 minutes. Then, the sponges were removed and the scleral surface was irrigated copiously with balanced salt solution. A 4x4 mm half thickness scleral flap was created. Under the flap 1x2 mm full thickness sclerostomy and an iridectomy were performed. The scleral flap was sutured with 2 to 4 interrupted 10-0 nylon sutures and then the conjunctiva-Tenon flap was sutured with a running 10-0 nylon suture. Trabeculectomy was not combined with other ocular surgeries and it was performed as a single procedure by one of the three surgeons (MY, ÜE, IY).

At the same session of PK, combined surgical procedures, such as cataract extraction, anterior chamber intraocular lens removal, lysis of synechias, anterior vitrectomy or scleral fixating intraocular lens placement, were performed whenever indicated.

Statistical analyses

Data were analyzed using SPSS version 17.0 statistical software (SPSS for Windows; SPSS Inc., Chicago, IL). Quantitative variables were shown as mean ± SD (median; range, minimum-maximum) and categorical variables as numbers and percentages. Chi-square test was used to compare categorical variables. Kruskal-Wallis test was used to compare

continuous variables between more than 2 independent groups. Logistic regression analysis was used to evaluate risk factors for trabeculectomy failure and odds ratio was used as a measure of association. Kaplan-Meier life-table analysis was used to calculate the cumulative survival rates in the whole sample and in the sub-groups stratified for each risk factor. Log-rank test was used to compare survival curves between groups. P values <0.05 were considered to be statistically significant.

RESULTS

During the study period, 60 patients underwent trabeculectomy after PK. Eight patients (8 eyes) were removed from further analysis due to incomplete data in patient charts and 6 patients (6 eyes) were removed due to less than 6 months of follow-up. Therefore, the study included 48 eyes of 46 patients (28 male and 18 female). Preoperative data were summarized in Table 1. Keratoconus and other corneal dystrophies were present in 16 eyes (33.3%) and the rest of the 32 eyes (66.7%) had various diseases (Table 1). Before trabeculectomy, 27 eyes (56.3%) underwent one or more additional surgeries at different sessions. In 9 eyes (18.7%), additional surgeries were performed at the same session of PK. Mean number of ocular surgeries before trabeculectomy (including PK) was 2.0 ± 1.5 (median, 2; range, 1-8). Twenty seven eyes (56.3%) were phakic before trabeculectomy.

Mean age was 33.7 ± 18.7 (median, 31; range, 6-81) years at PK and 35.1 ± 19.0 (median, 33; range, 7-82) years at the time of trabeculectomy. In 8 eyes (16.7%) glaucoma was present before PK. In the rest of the eyes mean time from PK to IOP elevation was 8.0 ± 9.7 (median, 4; range, 0.07-39) months and mean time from IOP elevation to trabeculectomy was 10.3 ± 9.6 (median, 9; range, 0.5-34) months. In the whole sample, mean time from PK to trabeculectomy was 19.0 ± 19.9 (median, 10.5; range, 1-96) months. Mean follow-up after trabeculectomy was 51.0 ± 51.7 (median, 35; range, 6-226) months. Due to the wide range in follow-up times, further analyses were performed for the first 2 years follow-up period.

At postoperative 24 months, complete success was achieved in 27 eyes (56.3%) and qualified success in 10 eyes (20.8%). Trabeculectomy failed to control IOP despite additional anti-glaucomatous medications in the rest of 11 eyes (22.9%). Table 2 summarizes preoperative data according to success groups and Table 3 describes odds ratios of preoperative risk factors for trabeculectomy failure according to logistic regression analysis.

Cumulative probability of surgical success in the whole sample and stratifications according to subgroups are demonstrated in Figure 1 based on Kaplan-Meier survival analysis. In the whole sample it was 91.7% at 3 months, 89.6% at 6 months, 82.5% at 9 months, 80.2% at 12 months, and 74.8%

Table 1. *Preoperative and intraoperative data of the study population.*

Keratoplasty indication	N (%)
Corneal dystrophies	16 (33.3)
Keratoconus	9 (18.8)
Macular corneal dystrophy	2 (4.2)
Granular corneal dystrophy	2 (4.2)
Congenital hereditary endothelial dystrophy	2 (4.2)
Fuchs endothelial dystrophy	1 (2.1)
Herpetic keratitis scar	7 (14.6)
Corneal leukoma with unknown etiology	6 (12.5)
Post-traumatic corneal scarring	5 (10.4)
Aphakic bullous keratopathy	3 (6.3)
Pseudophakic bullous keratopathy	4 (8.3)
Corneal opacities secondary to congenital glaucoma	3 (6.3)
Corneal alkali burn	1 (2.1)
Bacterial keratitis scar	1 (2.1)
Corneal opacities secondary to atopic keratoconjunctivitis	1 (2.1)
Corneal insufficiency secondary to endophthalmitis	1 (2.1)
Combined surgery with PK	N (%)
None	39 (81.3)
Lensectomy and bag IOL	3 (6.3)
Synechiotomy	2 (4.2)
AC IOL removal and scleral fixating IOL	1 (2.1)
Lensectomy and sulcus IOL	1 (2.1)
Lensectomy, bag IOL and synechiotomy	1 (2.1)
Lensectomy	1 (2.1)
Other surgeries before trabeculectomy[a]	N (%)
None	21 (43.8)
Cataract extraction	21 (43.8)
Second PK	7 (14.6)
Trabeculectomy	4 (8.3)
Corneal perforation repair	4 (8.3)
AC IOL removal	1 (2.1)
Amnion membrane transplantation	3 (6.3)
Pars plana vitrectomy	2 (4.2)
AC IOL removal and scleral fixating IOL	1 (2.1)
AC reformation	1 (2.1)
Pupilloplasty	1 (2.1)
Synechiotomy	1 (2.1)
Preoperative lens status	N (%)
Phakic	27 (56.3)
Pseudophakic	12 (25.0)
Aphakic	9 (18.8)
Anti-metabolite use	N (%)
Mitomycin-C	30 (62.5)
5-Fluorouracil	8 (16.7)
None	10 (20.8)

Abbreviations: PK, penetrating keratoplasty; IOL, intraocular lens; AC, anterior chamber. [a] Some eyes underwent more than one ocular surgery.

Table 2. *Distribution of preoperative data according to each success group.*

	Complete success (27 eyes)	Qualified success (10 eyes)	Failure (11 eyes)	
	N (%)	N (%)	N (%)	P
Male gender	18 (66.7)	6 (60.0)	6 (54.5)	0.770
Keratoplasty indication				
Corneal dystrophies	13 (48.1)	2 (20.0)	1 (9.1)	0.041
Others	14 (51.9)	8 (80.0)	10 (90.9)	
Previous glaucoma	4 (18.2)	2 (22.2)	2 (25.0)	0.910
Previous graft failure	1 (3.7)	2 (20.0)	5 (45.5)	0.007
Combined surgery with PK	4 (14.8)	3 (30.0)	2 (18.2)	0.575
Previous ocular surgery	13 (48.1)	6 (60.0)	8 (72.7)	0.370
Preoperative lens status				
Phakic	19 (70.4)	4 (40.0)	4 (36.4)	0.261
Pseudophakic	5 (18.5)	3 (30.0)	4 (36.4)	
Aphakic	3 (11.1)	3 (30.0)	3 (27.3)	
Anti-metabolite				
Mitomycin-C	19 (70.4)	6 (60.0)	5 (45.5)	0.065
5-Fluorouracil	2 (7.4)	4 (40.0)	2 (18.2)	
None	6 (22.2)	0	4 (35.4)	
	Mean ± SD (median, range)	Mean ± SD (median, range)	Mean ± SD (median, range)	
Follow up (months)	21.0 ± 5.9 (24, 6 - 24)	19.1 ± 7.5 (24, 6 - 24)	19.4 ± 6.1 (24, 8 - 24)	0.512
Number of previous ocular surgeries	1.5 ± 0.5 (2, 1 - 2)	2.6 ± 2.3 (2, 1 - 8)	2.7 ± 1.8 (2, 1 - 7)	0.069
Age at glaucoma surgery (years)	33.3 ± 17.6 (29, 13 - 71)	39.3 ± 21.4 (40.5, 9 - 70)	36.1 ± 21.7 (34, 7 - 75)	0.772
Time from PK to IOP elevation (months)	5.1 ± 7.8 (2, 0.1 - 27)	13.2 ± 13.1 (11, 0.3 - 39)	7.0 ± 6.0 (8, 1 - 16)	0.290
Time from IOP elevation to trabeculectomy (months)	8.1 ± 7.7 (8, 0.5 - 26)	16.9 ± 12.3 (13, 4 - 34)	5.9 ± 4.7 (9, 0.7 - 10)	0.108
Time from PK to trabeculectomy (months)	15.3 ± 15.1 (9.5, 3 - 60)	32.4 ± 29.6 (25.5, 5 - 96)	14.8 ± 13.2 (11, 1 - 48)	0.095
Preoperative IOP (mmHg)	40.4 ± 9.2 (40, 25 - 60)	39.4 ± 12.3 (35, 28 - 60)	39.3 ± 7.8 (39, 28 - 54)	0.808

Abbreviations: PK, penetrating keratoplaty; IOP, intraocular pressure.

at 18 months (95% confidence interval [CI], 18.2-22.3) (Figure 1a).

When stratified for intraoperative anti-metabolite use, it was 96.7% at 3 months, 93.3% at 6 months, 85.6% at 9 months, and 81.3% at 18 months in eyes with MMC (95% CI,19.0-23.5); 85.7% at 9 months and 71.4% at 12 months in eyes with 5-FU (95% CI,15.6-24.7); 70.0% at 3 months and 60.0% at 18 months in eyes without anti-metabolite (95% CI,11.3-22.9) (p =0.341, log rank test, Figure 1b).

When stratified for preoperative lens status, it was 96.3% at 3 months, 88.3% at 9 months, and 83.9% at 18 months in phakic eyes (95% CI,19.6-23.9); 83.3% at 3 months, 72.9% at 9 months, and 62.5% at 18 months in pseudophakic eyes (95% CI, 13.5-23.2); and 88.9% at 3 months, 77.8% at 6 months and 64.8% at 12 months in aphakic eyes (95% CI, 12.7-30.6) (p = 0.230, log rank test, Figure 1c).

When stratified for presence of previous ocular surgeries it was: 85.2% at 3 months, 81.5% at 6 months, 72.4% at 9 months and 67.9% at 12 months in eyes which had a history of one or more previous ocular surgery (95% CI, 15.0-21.6); and 95.0% at 9 months and 83.8% at 18 months in eyes which had no history of previous ocular surgery (95% CI, 21.0-24.2) (p = 0.124, log rank test, Figure 1d).

Table 3. *Univariate logistic regression analyses of preoperative factors for trabeculectomy failure.*

	Variables	Odds ratio	95% confidence interval	p value
Gender	Male	1		
	Female	1.5	0.4-6.0	0.536
Keratoplasty indication	Corneal dystrophies	1		
	Others	6.8	0.8-59.0	0.081
Glaucoma before PK	No	1		
	Yes	1.4	0.2-8.7	0.725
Previous graft failure	No	1		
	Yes	9.4	1.8-50.4	0.009
Combined surgery with PK	No	1		
	Yes	1	0.2-5.4	0.956
Previous ocular surgery other than PK	No	1		
	Yes	2.5	0.6-11.0	0.218
Preoperative lens status	Phakic	1		
	Pseudophakic	2.9	0.6-14.3	0.196
	Aphakic	2.9	0.5-16.5	0.236
Anti-metabolite	Mitomycin-C	1		
	5-Fluorouracil	1.7	0.3-10.8	0.592
	None	3.3	0.7-16.3	0.137

Abbreviation: PK, penetrating keratoplasty.

When stratified for corneal diseases it was 93.3% at 9 months in eyes with keratoconus or other corneal dystrophies (95% CI, 21.1-24.9); 87.5% at 3 months, 84.4% at 6 months, 77.0% at 9 months, 73.4% at 12 months, and 65.2% at 18 months in eyes with other etiologies (95% CI, 16.0-21.6) (p = 0.049, log rank test, Figure 1e).

When stratified for previous corneal graft failure it was 75.0% at 3 months, 50.0% at 9 months and 37.5% at 18 months in eyes with previous corneal graft failure (95% CI,8.2-20.3); and 95.0% at 3 months, 92.5% at 6 months, 89.6% at 9 months, 86.7% at 12 months and 83.4% at 18 months in eyes without previous corneal graft failure (95% CI, 19.6-23.4) (p = 0.004, log rank test, Figure 1f).

When the eyes which underwent PK for corneal dystrophies, without previous ocular surgeries, with phakic lens status, and with no corneal graft failure before trabeculectomy (10 eyes, 20.8%) were classified as low risk and the rest of the eyes (38 eyes, 79.2%) which had at least one risk factor for trabeculectomy failure as risky group, the cumulative probability of trabeculectomy success was found as 100% at 24 months in low risk group (95% CI, 21.9-24.6) while 89.5% at 3 months, 86.8% at 6 months, 77.5% at 9 months, 74.4% at 12 months, and 67.7% at 18 months in risky group (95% CI, 16.6-21.7) based on Kaplan-Meier survival analysis (p = 0.054, log rank test, Figure 2).

DISCUSSION

Patients with elevated IOP after PK may present with different clinical pictures. Determining the best surgical method for IOP control in these patients is often difficult and clinicians should decide the most appropriate method according to patient's clinical and social status. Although trabeculectomy remains as the gold standard method in controlling IOP in most types of glaucoma, its success rate is limited in eyes with PK.[2] The success rate of trabeculectomy in eyes with PK is highly variable in the literature because of variable study designs, study populations, surgical techniques, success criteria, and follow-up periods.[8-18] In conventional trabeculectomy (without intraoperative anti-metabolite) the success rates varies from 25% to 86%.[8-10,16] With adjunctive MMC the success rate increases to 49% to 94%.[11-18] In the current study, success rate of trabeculectomy was also higher in eyes with adjunctive anti-metabolite use than the eyes without but the difference did not reach statistical significance (Figure 1b).

Trauma, ocular surgeries, uveitis, and corneal graft rejection cause increased fibroblastic activity in the subconjunctival area, thus affecting trabeculectomy success adversely by bleb fibrosis.[9] Previous studies mostly investigated the outcomes of trabeculectomy in patients with PK who underwent multiple previous ocular surgeries or who had other

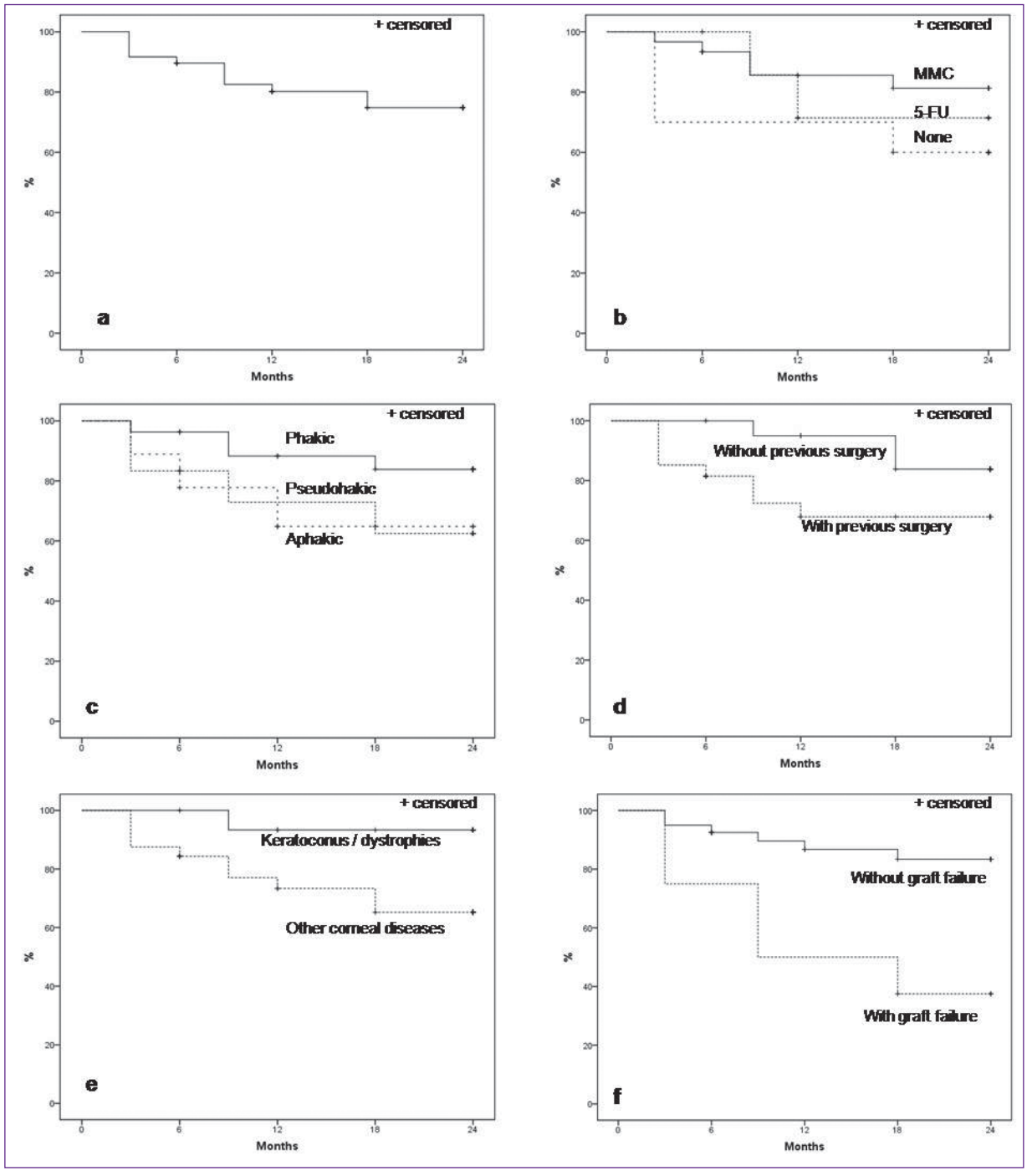

Figure 1. *Survival curve for trabeculectomy success in the whole sample (a) and stratified for intraoperative anti-metabolite use (b), preoperative lens status (c), previous ocular surgery (d), initial corneal disease (e), and previous corneal graft failure (f). classification of corneal dystrophies also includes keratoconus.*

risk factors for trabeculectomy failure, therefore comparison between low risk and high risk patients cannot be possible.[8-18] The current study has the advantage of including low risk patients and patients with various risk factors, and therefore, has the ability to assess each risk factor associated with trabeculectomy failure.

Gilvarry et al.[9] reported that eyes with multiple corneal grafts have adverse prognosis for trabeculectomy success. In the current study, the eyes with previous ocular surgery had 2.5 times higher risk of trabeculectomy failure and had lower survival rates than the eyes without previous ocular surgery although this difference did not reach statistical significance (Table 3, Figure 1d). WuDunn et al.[15] reported early bleb failure in eyes that underwent combined surgery with PK. No significant effect of combined surgery on trabeculectomy success was observed in the current study (Table 2 and 3).

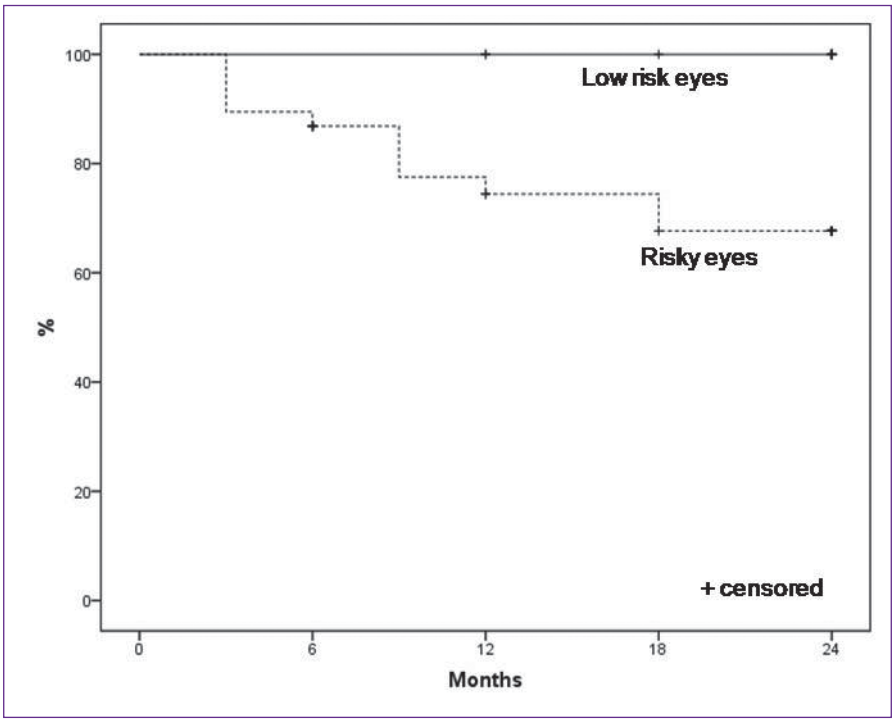

Figure 2. *Survival curve for trabeculectomy success according to preoperative risk status.*

Boey et al.[17] reported no significant relationship between initial corneal diagnosis and trabeculectomy outcomes. However, their study included only 4 eyes (10%) with Fuchs endothelial dystrophy, while no keratoconus or other corneal dystrophies were present. In the current study, the risk of trabeculectomy failure was 6.8 times higher in eyes with corneal diseases other than keratoconus/dystrophies than the eyes with keratoconus/corneal dystrophies (Table 3, Figure 1e).

Previous graft failure was the most strongly associated risk factor for trabeculectomy failure in the current study (Table 2 and 3). The eyes with a history of corneal graft failure had 9.4 times increased risk for trabeculectomy failure and had poor survival rate during follow-up (Figure 1f). Graft failure, especially secondary to immunologic reaction, and further grafting may cause increased inflammatory cells in the conjunctiva which ultimately lead trabeculectomy failure due to increased fibroblastic activity.[9, 19]

In conclusion, this study specifically investigated risk factors and survival rates of eyes with different preoperative risk factors, and tried to find the most appropriate patient group for successful outcomes for trabeculectomy in eyes with PK. According to our results, previous graft failure, preoperative lens status, initial corneal diagnosis and history of previous ocular surgery were associated factors with trabeculectomy success (Table 2 and 3). Although the last three factors did not reached statistical significance, this might be secondary to limited number of patients and follow up times in this study. Also removal of 14 patients from further analyses at the beginning of the study due to incomplete data or limited follow up, non-homogenous anti-metabolite use, inclusion of eyes with previous glaucoma and glaucoma surgery could affect the outcomes. This study involved a relatively young patient group (median 33 years at trabeculectomy) that might further affect our results as younger age is a well known risk factor for trabeculectomy failure.[19] A study including large and more homogenous cohort with longer follow up might give more precise results.

However, eyes without above mentioned risk factors had pretty good outcomes (100% success rate at 2 years follow up) after trabeculectomy (Figure 2). Therefore, trabeculectomy may be considered as the first-line surgical procedure in these eyes. Alternative surgical procedures, such as seton implants or cyclodestructive procedures, may be considered especially in eyes with a history of corneal graft failure.

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