Treatment outcomes in eyes with postkeratoplasty glaucoma

Fatma Sema Akkan Aydogmus[1], Oya Tekeli[2], Emine Esra Karaca[3], Ozlem Evren Kemer[4], Cenk Zeki Fikret[3], Dilay Ozek[3]

ABSTRACT

Purpose: To evaluate the clinical outcomes, surgical indications, results of medical, surgical and micropulse transscleral cyclophotocoagulation (MP-TSCPC) treatment in patients with postkeratoplasty glaucoma

Materials and Methods: Fifty-six eyes of 53 patients with glaucoma who had undergone keratoplasty were included in the study. Demographic and clinical characteristics, medical and surgical (either trabeculectomy or MP-TSCPC) treatment results were evaluated retrospectively.

Results: The mean age of patients was 52.8 ± 19.1 years (9- 84). The most common indication for keratoplasty was bullous keratopathy in 15 eyes (26.8 %). The mean follow-up period was 29.3 ± 36.7 months. Glaucoma control was achieved by medical treatment in 46 (82.1%), MP-TSCPC in 5 (8.9%), trabeculectomy in 3(5.4%), and combined therapy in 2 (3.6%) of eyes. For MP-TSCPC cases the mean pre-treatment IOP was 28.5 mmHg and the mean post-treatment IOP was 14.6 mmHg. With % 40 reduction, the best results were taken in MP-TSCPC group. No patients had hipotony or graft failure.

Conclusions: Glaucoma control can be achieved by medical, surgical and MP-TSCPC treatment in eyes with postkeratoplasty. MP-TSCPC is a safe and effective IOP lowering method in these eyes.

Keywords: Glaucoma, keratoplasty, micropulse laser, micropulse transscleral cyclophotocoagulation, postkeratoplasty glaucoma.

INTRODUCTION

Glaucoma following corneal transplantation is a common complication. The most important cause of high intraocular pressure (IOP) after keratoplasty has been shown to be pre-existing glaucoma.[1] The indication for corneal transplant also affects the incidence of post keratoplasty glaucoma, which occurs more frequently in eyes with aphakic bullous keratopathy and less frequently in Fuchs corneal dystrophy and keratoconus.[2] Other factors, include synechial angle closure, corticosteroid-induced elevation in IOP, iridocorneal angle collapse, postoperative inflammation and iatrogenic injury to the angle.[3] The incidence of glaucoma after penetrating keratoplasty (PK) is between 5.5% and 31% in the early postoperative period and between 17% and 35% in the late postoperative period.[4] While the incidence of glaucoma after Descemet's stripping endothelial keratoplasty (DSEK) was 29% -47%, this rate increased to 54% in patients with pre-existing glaucoma.[5] If glaucoma is not controlled, it may lead to irreversible vision loss due to progressive optic nerve damage and graft failure due to endothelial cell damage.[6] Surgical treatments of this type of glaucoma, which are often resistant to medical treatment, may cause damage to the graft. Therefore, new treatment options were needed.

Transscleral cyclophotocoagulation (TSCPC) is a form of cycloablation using laser to treat and it is effective for simple and complex glaucoma cases.[7] Traditional CPC is more effective than medical therapy at lowering IOP,

This study was presented as a poster at 2019 ESCRS Annual Congress, Paris, 2019 and at 2018 Turkish Ophthalmology Association National Congress, 2018 Antalya.

1- MD, Ophthalmology of Department, Ankara Bilkent City Hospital, Ankara, Türkiye

2- MD, Prof., Ophthalmology of Department, Faculty of Medicine, Ankara University, Ankara, Türkiye

3- MD, Assoc Prof., Ophthalmology of Department, Ankara Bilkent City Hospital, Ankara, Türkiye

4- MD, Prof.,Ophthalmology of Department, Ankara Bilkent City Hospital, Ankara, Türkiye

Received: 24.05.2023
Accepted: 06.10.2023
TJ-CEO 2024; 19: 58-62
DOI: 10.37844/TJ-CEO.2024.19.10

Correspondence author:
Fatma Sema Akkan Aydogmus
Email: semaakkan@gmail.com

Copyright © 2024 The author(s). This is an open-access article under the terms of the Creative Commons Attribution License (CC BY) which permits unrestricted use, distribution, and reproduction in any medium or format, provided the original work is properly cited.

but it can result in postoperative complications such as iridocyclitis, pain, intraocular hemorrhage, loss of vision, hypotony, phthisis bulbi, and macular edema.[8] Non-continuous delivery mode of TSCPC called micropulse transscleral cyclophotocoagulation (MP-TSCPC) has been developed to treat various retinal and glaucoma diseases.[9] MP-TSCPC (IRIDEX; CYCLO Glaucoma Laser System, Mountain View, CA) offers a minimal collateral damage and prevention of necrosis with pulsatile nature and "off-cycles," to treat glaucoma.[10]

There have been a few recent studies on the safety and efficacy of micropulse transscleral diode laser cyclophotocoagulation treatment (MP-TSCP), which has been used in many advanced cases of glaucoma.[11-17] In our knowledge, there is only one study in patients who had keratoplasty with MP-TSCP.[17] More study is needed on this subject. There is no study examining the medical, surgical and laser treatment results of patients followed up for glaucoma after keratoplasty.

The aim of this study was to evaluate the surgical indications, results of medical, surgical and micropulse transscleral cyclophotocoagulation (MP-TSCPC) treatment in patients with postkeratoplasty glaucoma.

MATERIALS AND METHODS

In this retrospective study, we included all patients with glaucoma who had undergone keratoplasty between 2010-2018 in the cornea department of University of Health Sciences, Ankara Numune Education and Research Hospital included in the study. Institutional review board approval was obtained from Ankara Numune Education and Research Hospital and the research was conducted in accordance with the tenets of the Declaration of Helsinki. Demographic characteristics, the indications for keratoplasty, follow-up times, type of surgery, presence of pre-existing glaucoma, the mean time from corneal transplantation to glaucoma formation, presence of additional surgery, type of treatment, intraocular pressure before and after treatment, and number of medications were recorded retrospectively.

The diagnosis of glaucoma in eyes with keratoplasty was made by perimetric identification of characteristic visual field defects as well as progressive excavation or 'cupping' of the optic nerve from focal or diffuse thinning of the optic nerve rim or loss of retinal nerve fiber layer in optic coherence tomography. Surgical operations of the patients were performed at Cornea-Glaucoma department of Ankara Numune Training and Research Hospital. The indication for surgery was uncontrollable IOP or progressive glaucoma despite maximal tolerated medical therapy. Under local or general anesthesia, a fornix-based conjunctiva and tenon flap was created. Then, 0.2 mg/mL mitomycin C or 50 mg/mL 5-fluorouracil-soaked sponges were applied subconjunctivally over a wide scleral area where the scleral flap was planned. The sponges were then removed, and copious irrigation with balanced salt solution was performed. Four mm half-thickness scleral flap was prepared. Under the sclera flap, 1-2 mm full thickness sclerostomy was created and iridectomy was performed through the scleral ostium. The scleral flap and conjunctiva were closed with 10-0 nylon sutures. The Ahmed glaucoma valve implantation procedure was performed under retrobulbar or peribulbar anesthesia. The conjunctival incision was made posteriorly by blunt dissection in the superotemporal quadrant, and a fornix-based conjunctival flap was created. The valve implant was irrigated with 2 mL of balanced saline solution using a 27-gauge cannula through the tubing to open the valve mechanism. The plate of the valve was inserted between the superior and lateral rectus muscles, and then joined to the sclera with 7-0 prolene sutures at least 10 mm posterior to the limbus. The drainage tube was trimmed with the bevel facing up and was placed in the anterior chamber through a 23-gauge needle track to allow 2 mm proximity to the limbus. The needle track was anterior and parallel to the plane of the iris. The drainage tube was covered with a donor scleral flap of approximately 4 × 4 mm2 in size and secured at the four corners of the sclera with 10-0 nylon sutures. The conjunctiva and Tenon's capsule layer were anchored to the limbus with 8-0 vicryl sutures.

Laser treatments were performed once with MP-TSCPC (IRIDEX; CYCLO Glaucoma Laser System, Mountain View, CA) at Glaucoma department of Ankara University Medical Faculty Hospital. MicroPulse P3 (MP3) probe was applied at the limbus with the probe perpendicular to the surface of the globe. The sites of previous filtering surgery/tubes, areas of thin sclera, and the 3 and 9 o'clock positions (to avoid the long posterior ciliary nerves) were spared. Laser settings were 2000mW with 0.5 ms on and 1.1 ms off time (duty cycle of 31.3%). The laser was applied throughout 180° for 80s. The same procedure was repeated for the other hemifield. Topical steroid drops were used postoperatively. All patients received loteprednol etabonate drops 1% four times a day with a tapering within 3 weeks.[10]

Success in evaluating treatment results; intraocular pressure was 6 - 21 mmHg or 20% or more decrease

compared to pretreatment in MP-TSCPC group. Glaucoma surgical success was defined as having an IOP 6-21 mmHg with or without antiglaucomatous medications, without the need for further glaucoma surgery and without loss of light perception.

Statistical Package for the Social Sciences programme version 22.0 (SPSS for Windows, SPSS, Chicago, IL) was used for statistical analysis of the data obtained from the study. Descriptive statistics were expressed in mean ±standard deviation (SD) and range (min-max) values. Numerical variables were expressed as mean ± standard deviation, and categorical data were given as numerical values and percentages.

RESULTS

Fifty-six eyes of 53 patients with glaucoma who had undergone keratoplasty included in the study. The patients of the study were 24 women (42.9%), 32 men (52.1%) and the mean age of was 52.82 ±19.13 (range 9-84). Twenty eyes were right (37.73%), 30 eyes were left (56.60%) and 3 eyes were bilateral (5.66%). The patient's demographic and clinical features are presented in Table 1 and Table 2. Indication for keratoplasty was bullous keratopathy in 15 eyes (26.8%), traumatic keratopathy in 11 (19.6%), keratoconus in 8(14.3%), silicone keratopathy in 7 (12.5%), keratitis in 7 (12.5%), dystrophy in 2 (3.6%), unknown scar in 2 (3.6%) and endothelial failure secondary to dexamethasone implant in 2 (3.6%) of patients. The mean follow-up period was 29.33 ± 36.77 months (range 2-204) and the mean time from transplantation to glaucoma formation was 6.36 ± 8.46 months (range 1-36, median: 4.5). Forty-seven patients had experienced PK (83.9%), 4 eyes had experienced deep anterior lamellar keratoplasty (DALK) (7.1%), 5 eyes had experienced Descemet membrane endothelial keratoplasty (DMEK) (8.9%). Twenty eyes (35.7 %) had preexisting glaucoma and 36 eyes (65.3%) developed after transplantation. There was history of previous vitreoretinal surgery in 19 eyes (33.9%). Glaucoma control was achieved by medical treatment in 46 (82.1%), MP-TSCP in 5 (8.9%), trabeculectomy (TRAB) in 3 (5.4%), and combined therapy (one is TRAB and MP-TSCP, one is TRAB and Ahmed glaucoma valve implant) in 2 (3.6%) of eyes. The mean pre-treatment intraocular pressure (IOP) was 24.96 ± 8.89 mmHg (range 12-45), after treatment IOP was 19.64 ± 8.65 mmHg (range 6-25). The success rate was variable in the medical treatment group, 5 patients needed TRAB. Success was achieved in 3 of them, for 1 patient the MP-TSCP treatment is added and for 1 patient shunt is added to succeed in the treatment. The mean pre-treatment IOP of 6 patients with MP-TSCP was 28.5 mmHg and the mean post-treatment IOP was 14.6 mmHg (Graphic 1). With % 40 reduction, the best result was taken in MP-TSCP. No patient had hypotony, graft failure or loss of best-corrected visual acuity.

Table 1: *Patients' clinical and demographic features*

	Mean ± SD	Minimum	Maximum
Age	52,82 ± 19,13	9	84
Follow up time (month)	29,33 ± 36,77	2	204
the mean time from transplantation to glaucoma formation (month)	6,36 ± 8,46	1	36
IOP pre-treatment (mmHg)	24,96 ± 8,89	12	45
IOP after the treatment (mmHg)	19,64 ± 8,65	6	37

IOP: intraocular pressure, SD: standart deviation

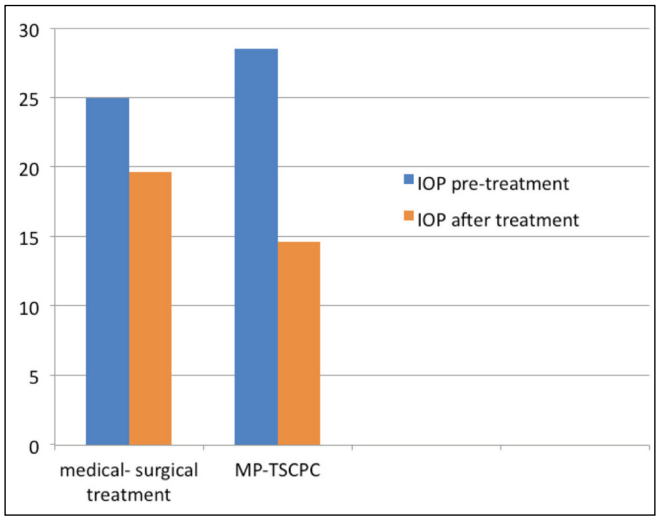
Table 2: *Patients' clinical and demographic features*

		n (patient number)	%
Gender	Female	24	42,9
	Male	32	57,1
Laterality	Right	20	37,7
	Left	30	56,6
Pre-existing glaucoma	Yes	20	35,7
	No	36	64,3
Operation type	PK	47	83,9
	DALK	4	7,1
	DMEK	5	8,9
Additional operation	No	37	66,1
	With PPV	19	33,9

DALK: deep anterior lamellar keratoplasty, DMEK: Descemet membrane endothelial keratoplasty, PK: penetrating keratoplasty, PPV: pars plana vitrectomy

DISCUSSION

Glaucoma that appears after the keratoplasty is one of the important reasons behind the loss of vision and irreversible graft failure. Pre-existing glaucoma and aphakia are known as the most important risk factors of this condition.[17] Viscoelastic use, angle distortion with collapse of trabecular network, synechial angle closure, steroid using, and many secondary glaucoma causes such as pupillary block, inflammatory glaucoma are the main mechanisms in glaucoma development.[3] The increase of



IOP: intraocular pressure, MP-TSCPC: micropulse transscleral cyclophotocoagulation

Graphic 1: *Intraocular pressure changes before and after treatment.*

IOP after the PK shows a bimodal distribution. In the early postoperative period, intraocular pressure increases due to viscoelastic using in many patients. Many researches show that glaucoma incidence is changing as between 5.5 – 31% in early postoperative period while the number is between 17-35% in the late postoperative period.[4] While the incidence of glaucoma after DSEK was 29-47%, this rate increased to 54% in patients with previous glaucoma.[5] Borderie et al.[18] shows that the incidence of glaucoma after DALK and DMEK was found to be significantly reduced compared to PK, which was attributed to the fact that the damage to the anterior chamber angle and trabecular network was less due to lamellar surgery. In our study, we found that there is a significant decrease in the IOP increase based on PK after DALK and DMEK surgery. But this result could be due to the small number of DALK and DMEK patients. Options for the treatment of glaucoma are medical treatment, surgery, glaucoma drainage devices and cyclodestructive procedures. Many eyes with glaucoma after keratoplasty respond well to medical treatment.[2] In our study, glaucoma was controlled with medication in 82.1% of the patients. Glaucoma surgeries cause graft failure and the use of antimetabolites may exacerbate rejection with endothelial cell loss.[19] Yakin et al.[20] showed that while TRAB's effectiveness on the decrease in IOP was 58.3%, 64.3% by the TRAB with antimetabolite using and it is 86.7% using glaucoma drainage devices. Moreover, corneal graft health is found as 60% in third year with TRAB, 67.7% using TRAB with antimetabolite using and 52,6% with glaucoma drainage devices.[20] In another study, the lowering effect was 58.3% of TRAB alone, 64.3% of TRAB with antimetabolite using and 86.7% of glaucoma drainage devices. Corneal graft health was 60% in TRAB in the third year, 67.7% in TRAB with antimetabolite using and 52.6% in glaucoma drainage devices.[21] Cyclodestructive procedures, which are another alternative in glaucoma treatment, are cyclocriyotherapy, Nd: Yag laser cyclophotocoagulation (CPC), diode laser CPC, transpupillary argon laser photocoagulation and endoscopic CPC.[19] These procedures are preferred in end-stage glaucoma patients with low visual potential. Because, it has some side effects as graft failure, hypotonia, loss of vision and phytisis bulbi. The newly developed MP-TSCPC is a system which is applied with the assistance of a prob using diode laser and replaces the old cyclodesturative processes. MP-TSCPC was found to be highly effective and safe in a group of patients with advanced glaucoma and no other treatment option.[11,12,21]

Micropulse transscleral cyclophotocoagulation is a very safe form of treatment under local anesthesia with lower energy without conjunctival scar formation in office conditions.[10,13-16,22] One of the most important advantages is that it is reproducible. In a study of 40 eyes by Tan et al.[21] no patients had hypotonia and visual loss, and this treatment was reported to be highly effective and safe. Although clinical studies mostly cover advanced glaucoma patients, Dr. Fox[22] highlights that this treatment can be applied to more various patient groups and Tekeli et al.[10] found that MP-TSCPC is an effective method in different types of glaucoma. We also performed MP-TSCPC in 6 patients whose glaucoma developed after the keratoplasty. We did not face with any vision lose, graft failure or any other complications in any patients. Moreover, we ensured nearly 50% IOP decrease in these patients. In a MP-TSCPC study performed in keratoplasty eyes, it was concluded that MP-TSCPC is a noninvasive alternative to glaucoma filtration surgery.[17]

Some of the limitations of our study are small number of patients in MP-TSCPC treatment, limited follow-up, and retrospective nature of study. However, we think that larger-scale studies are needed in the future, as this study is one of the first studies to have applied MP-TSCPC treatment in eyes with glaucoma after keratoplasty. Also, this study is unique examining various treatment options in postkeratoplasty glaucoma.

CONCLUSION

Glaucoma appearing following the corneal transplantation is a frequently seen complication. It forms a difficult patient group due to the hardships in the diagnosis and the treatment

phases. All treatment options in postkeratoplasty glaucoma were examined in this study. By MP-TSCPC treatment, the IOP decrease was ensured and quite successful results were obtained. However, there is a need more studies done with large patients' population on this topic.

REFERENCES

1. Karadag O, Kugu S, Erdogan G, et al. Incidence of and risk factors for increased intraocular pressure after penetrating keratoplasty. Cornea 2010;29:278-82. https://doi.org/10.1097/ICO.0b013e3181b6eb9e
2. Huber KK, Maier AK, Klamann MK, et al. Glaucoma in penetrating keratoplasty: risk factors, management and outcome. Graefes Arch Clin Exp Ophthalmol 2013;251:105-16. https://doi.org/10.1007/s00417-012-2065-x
3. Byrd S, Tayeri T. Glaucoma associated with penetrating keratoplasty. Int Ophthalmol Clin 1999;39:17-28. https://doi.org/10.1097/00004397-199903930-00004
4. Foulks GN. Glaucoma associated with penetrating keratoplasty. Ophthalmology 1987;94:871-4. https://doi.org/10.1016/s0161-6420(87)33542-0
5. Vajaranant TS, Price MO, Price FW, et al. Visual acuity and intraocular pressure after Descemet's stripping endothelial keratoplasty in eyes with and without preexisting glaucoma. Ophthalmology 2009;116:1644-50. https://doi.org/10.1016/j.ophtha.2009.05.034
6. Aldave AJ, Rudd JC, Cohen EJ, et al. The role of glaucoma therapy in the need for repeat penetrating keratoplasty. Cornea 2000;19:772-6. https://doi.org/10.1097/00003226-200011000-00002
7. Jurjevic D, Funk J, Töteberg-Harms M. Cyclodestructive procedures to lower intraocular pressure - a review. Klin Monbl Augenheilkd 2019;236:63-8. https://doi.org/10.1055/s-0043-105271
8. Ndulue JK, Rahmatnejad K, Sanvicente C, et al. Evolution of cyclophotocoagulation. J Ophthalmic Vis Res 2018;13:55-61. https://doi.org/10.4103/jovr.jovr_190_17
9. Meyer JJ, Lawrence SD. What's new in laser treatment for glaucoma? Curr Opin Ophthalmol 2012;23:111-7. https://doi.org/10.1097/ICU.0b013e32834f1887
10. Tekeli O, Köse HC. Outcomes of micropulse transscleral cyclophotocoagulation in primary open-angle glaucoma, pseudoexfoliation glaucoma, and secondary glaucoma. Eur J Ophthalmol 2021;31:1113-21. https://doi.org/10.1177/1120672120914231
11. Yelenskiy A, Gillette TB, Arosemena A, et al. Patient outcomes following micropulse transscleral cyclophotocoagulation: intermediate-term results. J Glaucoma 2018;27:920-5. https://doi.org/10.1097/IJG.0000000000001023
12. Kuchar S, Moster MR, Reamer CB, et al. Treatment outcomes of micropulse transscleral cyclophotocoagulation in advanced glaucoma. Lasers Med Sci 2016;31:393-6. https://doi.org/10.1007/s10103-015-1856-9
13. Ariga M, Nivean PD, Madanagopalan VG, et al. Micropulse trans-scleral diode laser cyclophotocoagulation in refractory glaucoma: an initial experience in Indian eyes. Int Ophthalmol 2021;41:2639-45. https://doi.org/10.1007/s10792-021-01697-1
14. Fili S, Vastardis I, Perdikakis G, et al. Transscleral cyclophotocoagulation with MicroPulse® laser versus cyclophotocoagulation with continuous diode laser in patients with open-angle glaucoma. Int Ophthalmol 2022;42:525-39. https://doi.org/10.1007/s10792-021-02023-5
15. Maestri F, Legrand M, Da Cunha E, et al. Micropulsed diode laser transscleral cyclophotocoagulation: an effective technique whose role remains to be defined. J Fr Ophtalmol 2021;44:350-7. https://doi.org/10.1016/j.jfo.2020.09.006
16. Haddadin RI, Chodosh J. Corneal transplantation and glaucoma. Semin Ophthalmol 2014;29:380-96. https://doi.org/10.3109/08820538.2014.959201
17. Subramaniam K, Price MO, Feng MT, et al. Micropulse transscleral cyclophotocoagulation in keratoplasty eyes. Cornea 2019;38:542-5. https://doi.org/10.1097/ICO.0000000000001897
18. Borderie VM, Loriaut P, Bouheraoua N, et al. Incidence of intraocular pressure elevation and glaucoma after lamellar versus full-thickness penetrating keratoplasty. Ophthalmology 2016;123:1428-34. https://doi.org/10.1016/j.ophtha.2016.03.034
19. Kornmann HL, Gedde SJ. Glaucoma management after corneal transplantation surgeries. Curr Opin Ophthalmol 2016;27:132-9. https://doi.org/10.1097/ICU.0000000000000237
20. Yakin M, Eksioglu U, Yalniz-Akkaya Z, et al. Outcomes of trabeculectomy and glaucoma drainage devices for elevated intraocular pressure after penetrating keratoplasty. Cornea 2018;37:705-11. https://doi.org/10.1097/ICO.0000000000001590
21. Tan AM, Chockalingam M, Aquino MC, et al. Micropulse transscleral diode laser cyclophotocoagulation in the treatment of refractory glaucoma. Clin Exp Ophthalmol 2010;38:266-72. https://doi.org/10.1111/j.1442-9071.2010.02238.x
22. Fox J. Cyclophotocoagulation Controversy. Glaucoma Today 2017. Available at: https://glaucomatoday.com/articles/2017-mar-apr/cyclophotocoagulation-controversy.