

Phacoemulsification in eyes with corneal opacities after deep anterior lamellar keratoplasty

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Abstract

• To evaluate the maneuverability and efficacy of phacoemulsification and intraocular lens (IOL) implantation in eyes with corneal opacities after deep anterior lamellar keratoplasty (DALK), twelve eyes of 12 patients with mild to moderate corneal opacities after DALK and coexisting cataracts were analyzed retrospectively. Phacoemulsification and IOL implantation assisted with anterior capsule staining, as well as non-invasive optical fiber illumination, were performed on all eyes. No intraoperative or postoperative complications were noted. Mean corrected distance visual acuity (logMAR) improved from 1.24 ± 0.17 to 0.73 ± 0.22 . Post-phaco intraocular pressure was maintained between 13 to 20 mm Hg in all cases throughout the follow-up period. Mean endothelial cell density decreased from 2258.42 ± 205.94 to 1906.25 ± 174.23 cells/mm². Phacoemulsification and IOL implantation are safe and valid in eyes with mild to moderate corneal opacities after DALK and coexisting cataracts when assisted with anterior capsule staining and non-invasive optical fiber illumination.

• **KEYWORDS:** phacoemulsification; corneal opacity; deep anterior lamellar keratoplasty; staining; illumination

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INTRODUCTION

Deep anterior lamellar keratoplasty (DALK) that only replaces the diseased part of the cornea while preserving the recipient's Descemet membrane and endothelium

minimizes the complications of replacing the full-thickness cornea [penetrating keratoplasty (PK)]^[1-2]. Moreover, improvements in DALK techniques have also enhanced its usefulness for treatment of corneal disease in patients with non-compromised endothelium^[3-4].

Although less than that associated with PK^[5-6], the risk of recurrence and graft rejection episodes after DALK also exists, potentially leaving a mild to moderate corneal opacity. In modern China, keratoplasty still faces many challenges, including the large numbers of patients, a lack of corneal donors, and limited medical funding^[7]. These challenges greatly reduce the chance of a patient receiving another keratoplasty after suffering a mild to moderate corneal opacity after the first procedure. In patients with coexisting cataracts, capsulorhexis and phacoemulsification are difficult because of poor visibility of the crystalline lens and anterior capsule^[8]. The protection of the graft and endothelium should also be considered during operation.

Previous studies have shown that phacoemulsification after DALK is safe and provides an improvement in the visual acuity of eyes with transparent corneas^[4,9-10]. But few studies are available on phacoemulsification in eyes with mild to moderate corneal opacities after DALK. To overcome above difficulties, we performed a non-invasive optical fiber illumination-assisted phacoemulsification and IOL implantation procedure in eyes with mild to moderate corneal opacities after DALK and the efficacy of the procedure was evaluated.

SUBJECTS AND METHODS

Ethical Approval The study was conducted in accordance with the Declaration of Helsinki and was approved by the Research Ethics Committee of Tongji Hospital Affiliated with Tongji University School of Medicine. Informed consent was waived due to the retrospective nature of the study.

Subjects This retrospective analysis comprised 12 eyes with mild to moderate corneal opacities after DALK that underwent optical fiber illumination-assisted phacoemulsification and IOL implantation by the same senior surgeon (Bi YL) between March 2013 and April 2017 in the Department of Ophthalmology, Tongji Hospital Affiliated with Tongji University School of Medicine, Shanghai, China. One eye with a preexisting posterior synechia was diagnosed with

phacomorphic glaucoma during the follow-up period after DALK. Eyes with severe corneal opacities, active inflammation, lens dislocation, and fundus lesions were excluded.

Pre-phaco Examination Corrected distance visual acuity (CDVA) and slit-lamp microscopic examination were performed in all eyes. Intraocular pressure (IOP) was measured by a Tono-Pen (SW-500; SUOER, China). Endothelial cell density (ECD) was detected by confocal microscopy (Confoscan 3.0; NIDEK, Japan). The axial length was measured by partial coherence interferometry (PCI; IOLMaster 500; Carl Zeiss, Germany). Keratometry readings were obtained using corneal topography (ATLAS 9000; Carl Zeiss, Germany) and then manually inserted into the PCI device to determine the spherical IOL power using the SRK-T formula.

Surgical Technique All operations were performed by the same senior surgeon (Bi YL) under retrobulbar anesthesia. Care was taken to avoid contact with the graft-host junction when making two corneoscleral limbus incisions. Through a 2.7 mm corneoscleral limbus incision, an air bubble was injected into the anterior chamber. Of 0.1% trypan blue was injected over the anterior capsule within the air bubble to improve visibility of the capsule and a viscoelastic substance was then used to maintain the anterior chamber (Figure 1A). Adjusting the surgical microscope to smaller aperture and higher coaxial illumination would provide a deeper depth of field, which can improve the distinguishability of the lens to some degree (Figure 1B). But in these cases, the above steps would not provide enough visibility for the subsequent procedure. Considering this, a non-invasive optical fiber used as the only light source to further enhance visibility. With an appropriate projection angle and distance, the lens can be observed clearly (Figure 1C). The continuous curvilinear capsulorhexis and hydrodissection were performed conventionally. Phacoemulsification was performed using a divide-and-conquer technique with a low vacuum and flow rate (Figure 1D). After the implantation of a foldable IOL and aspiration of the viscoelastic substance, the incisions were hydrated closed.

Post-phaco Protocol All eyes received levofloxacin 0.5%, Tobradex (tobramycin 0.3% and dexamethasone 0.1%) and pranopfen 0.1% eye drops postoperatively, which were gradually tapered and then stopped after one month. Patients received follow-up regularly after discharge. CDVA, IOP, ECD, and slit-lamp microscopic examination accompanied each visit.

Statistical Analysis Statistical analyses were performed using SPSS 11.0. Data were shown as mean±SD. Comparisons between pre-phaco and post-phaco ECD were performed using a paired-samples *t*-test. $P < 0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Twelve eyes of 12 patients were included in the study and

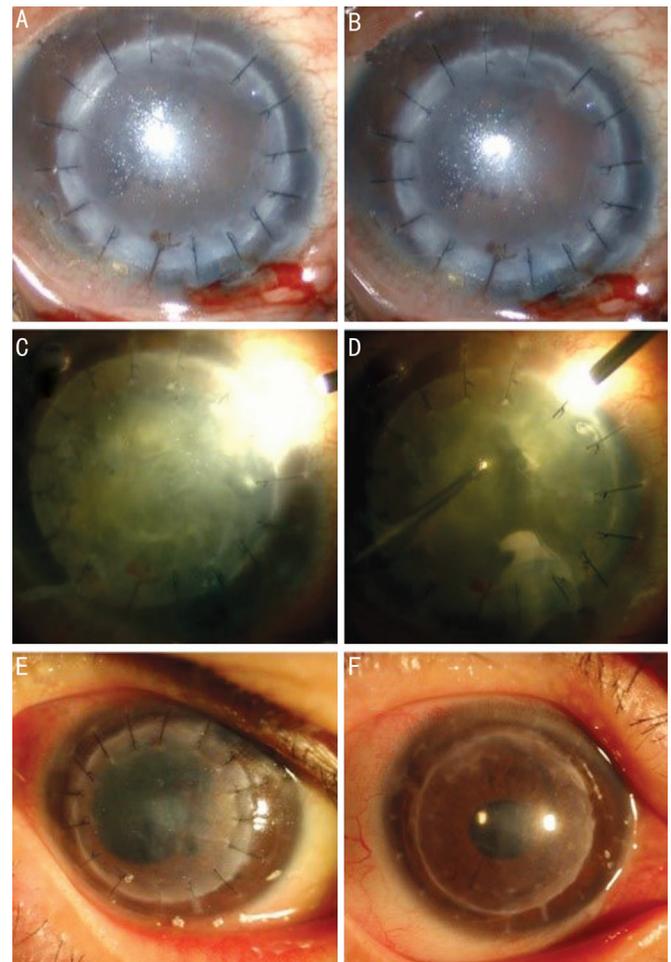


Figure 1 Microscope views taken during surgery, and the slit-lamp photo of the right eye of patient 1 A: After staining with 0.1% trypan blue, the anterior capsule was still indiscernible; B: The visibility improved slightly with a smaller aperture and higher coaxial illumination; C: A non-invasive optical fiber improved the visibility significantly; D: The position and projection angle of the optical fiber could be changed as needed; E: Four months after DALK, the eye with the preexisting posterior synechia presented cataract swelling, anterior chamber shallowing and sustained IOP elevation; F: Five months after phacoemulsification with lysis of the posterior synechia and goniosynechialysis, the graft was stable without edema.

the patient characteristics are shown in Table 1. The mean age was 61.33 ± 5.76 y. The mean interval between DALK and phacoemulsification was 13.50 ± 3.48 mo. For a final accurate prediction of IOL power, phacoemulsification was performed in all eyes after full suture removal^[11] (at least 12 mo after DALK; Figures 2-3), except for one eye (Figure 1E) with preexisting posterior synechia presenting phacomorphic glaucoma beyond the control of topical antiglaucoma medications during the follow-up period after DALK. The IOP in this eye maintained between 32 to 38 mm Hg with three medications (pilocarpine 0.5%, carteolol 2% and brimonidine 0.2% eye drops). Mannitol 20% given one-half hour before operation reduced IOP to 25 mm Hg and phacoemulsification with lysis of the posterior synechia and goniosynechialysis was

Table 1 Patient characteristics

Patient No./sex/age (y)	Reason for DALK	ECD (cells/mm ²)		CDVA	
		Pre-phaco	Post-phaco ^a	Pre-phaco	Post-phaco ^a
1/M/54	Infective leucoma	2570	2114	20/500	20/100
2/F/70	Infective leucoma	2022	1687	20/667	20/200
3/M/61	Traumatic leucoma	2285	1907	20/500	20/200
4/M/58	Fungal keretitis	2334	2005	20/333	20/80
5/M/68	Mooren's ulcer	2087	1733	20/200	20/50
6/F/64	Infective leucoma	2045	1721	20/250	20/133
7/M/52	Fungal keretitis	2642	2245	20/500	20/133
8/M/63	Infective leucoma	2125	1836	20/333	20/166
9/M/55	Fungal keretitis	2475	2084	20/250	20/66
10/M/58	Traumatic leucoma	2316	1968	20/250	20/80
11/M/69	Infective leucoma	2032	1699	20/200	20/50
12/M/64	Infective leucoma	2168	1876	20/500	20/200

DALK: Deep anterior lamellar keratoplasty; ECD: Endothelial cell density; CDVA: Corrected distance visual acuity.

^a12mo after phacoemulsification.

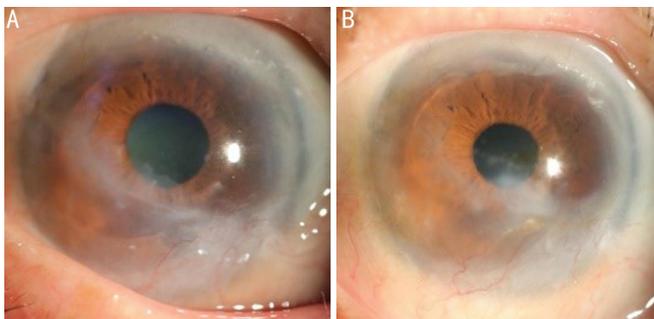


Figure 2 Pre-phaco and post-phaco slit-lamp photos of patient 5 A: Thirteen months after partial DALK; B: One month after phacoemulsification.

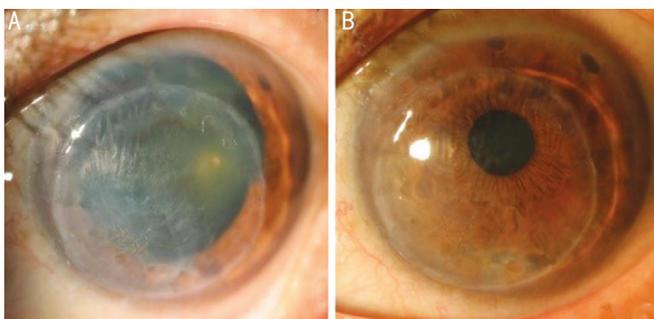


Figure 3 Pre-phaco and post-phaco slit-lamp photos of patient 11 A: Twelve months after DALK; B: One month after phacoemulsification.

performed four months after DALK. Post-phaco IOP of this eye maintained between 14 to 20 mm Hg without medications, and the graft was stable without edema (Figure 1F). Glaucoma is well recognized as an independent cause of keratoplasty failure^[12-13], so the timing of surgery is crucial. One article reported a case in which phacoemulsification was performed four months after DALK and no intraoperative or postoperative complications were noted^[4]. Likewise, the case in this study also suggests that phacoemulsification after DALK is safe with an interval of four months.

Operations were uneventful in all cases. No complications were noted during or after phacoemulsification and IOL implantation. IOP maintained between 13 to 20 mm Hg in all cases throughout the follow-up period. The mean ECD decreased from 2258.42 ± 205.94 to 1906.25 ± 174.23 cells/mm² ($P < 0.05$). The mean CDVA (logMAR) improved from 1.24 ± 0.17 to 0.73 ± 0.22 . In eyes with cataracts and coexisting corneal diseases, a triple procedure^[14-15] and 2-stage procedure^[4] are available. Although the triple procedure enables faster recovery and fewer follow-up visits, inaccuracy in IOL power prediction is a major drawback^[15]. Moreover, the need for cataract surgery may emerge after keratoplasty in eyes with no preexisting lenticular changes or severe corneal opacity limiting the preoperative detection of cataracts. So, the 2-stage procedure is still required in many cases.

Performing phacoemulsification in eyes with preexisting corneal opacities is challenging because of poor visibility of the lens and anterior chamber. Anterior chamber endoillumination and transconjunctival chandelier retroillumination have reportedly been used in cataract surgery to enhance visibility^[8,16]. But these procedures also have limits. Anterior chamber endoillumination occupies space in the anterior chamber and the position is inconvenient to change. Transconjunctival chandelier retroillumination used in vitreoretinal surgery may result in retinal phototoxicity^[17-19]. In this study, a non-invasive optical fiber was used as the only light source to decrease the light scatter caused by corneal opacity and further enhance visibility. The non-invasive optical fiber does not need additional incisions and has smaller influence on the cornea, which is especially important in eyes after DALK. Further, it has better mobility and does not occupy the space of the anterior chamber, making anterior chamber manipulation progress more smoothly. The slant projection angle also reduces microscope-induced retinal phototoxicity^[20-21].

After solving the problem of illumination, the other thing to be noticed is the protection of the graft and endothelium. Corneoscleral limbus incisions should avoid contact with the graft-host junction. Staining of the anterior capsule under an air bubble reduced contact between the dye and the corneal endothelium. Minimize movement of the tip to reduce its influence on the graft-host junction. A low vacuum and flow rate were required to decrease turbulence in the anterior chamber and to minimize the damage to the graft-host junction and endothelium. For safety, this technique should be performed in eyes with a nucleus up to grade III (according to the Emery-Little classification), to decrease endothelial cell loss caused by high ultrasonic energy^[14,22].

There were also some limitations in this study, such as the small sample size and the need for an assistant during the surgery. More appropriate cases will be comprised in the future. Moreover, the holder for the non-invasive optical fiber is in the design.

In conclusion, for patients with coexisting cataracts and mild to moderate corneal opacities after keratoplasty but who are unable to undergo another keratoplasty due to a lack of corneal donors or financial concerns, this study provided a safe and valid technique for enhancing their postoperative visual acuity to some extent and at lower cost.

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REFERENCES

- 1 Feizi S, Javadi MA, Daryabari SH. Factors influencing big-bubble formation during deep anterior lamellar keratoplasty in keratoconus. *Br J Ophthalmol* 2016;100(5):622-625.
- 2 Chen G, Tzekov R, Li W, Jiang F, Mao S, Tong Y. Deep anterior lamellar keratoplasty versus penetrating keratoplasty: a meta-analysis of randomized controlled trials. *Cornea* 2016;35(2):169-174.
- 3 Luengo-Gimeno F, Tan DT, Mehta JS. Evolution of deep anterior lamellar keratoplasty (DALK). *Ocul Surf* 2011;9(2):98-110.
- 4 Leccisotti A, Islam T, McGilligan VE, Moore TC. Phacoemulsification after deep anterior lamellar keratoplasty. *Eur J Ophthalmol* 2010;20(4):680-683.
- 5 Wu SQ, Zhou P, Zhang B, Qiu WY, Yao YF. Long-term comparison of full-bed deep lamellar keratoplasty with penetrating keratoplasty in treating corneal leucoma caused by herpes simplex keratitis. *Am J Ophthalmol* 2012;153(2):291-299.e2.
- 6 Akanda ZZ, Naeem A, Russell E, Belrose J, Si FF, Hodge WG. Graft rejection rate and graft failure rate of penetrating keratoplasty (PKP) vs lamellar procedures: a systematic review. *PLoS One* 2015;10(3):e0119934.

- 7 Hong J, Shi W, Liu Z, Pineda R, Cui X, Sun X, Xu J. Limitations of keratoplasty in china: a survey analysis. *PLoS One* 2015;10(7):e0132268.
- 8 Oshima Y, Shima C, Maeda N, Tano Y. Chandelier retroillumination-assisted torsional oscillation for cataract surgery in patients with severe corneal opacity. *J Cataract Refract Surg* 2007;33(12):2018-2022.
- 9 Acar BT, Utine CA, Acar S, Ciftci F. Endothelial cell loss after phacoemulsification in eyes with previous penetrating keratoplasty, previous deep anterior lamellar keratoplasty, or No previous surgery. *J Cataract Refract Surg* 2011;37(11):2013-2017.
- 10 Lockington D, Wang EF, Patel DV, Moore SP, McGhee CN. Effectiveness of cataract phacoemulsification with toric intraocular lenses in addressing astigmatism after keratoplasty. *J Cataract Refract Surg* 2014;40(12):2044-2049.
- 11 Feizi S, Javadi MA, Behnaz N, Fani-Hanife S, Jafarinasab MR. Effect of suture removal on refraction and graft curvature after deep anterior lamellar keratoplasty in patients with keratoconus. *Cornea* 2018;37(1):39-44.
- 12 Wandling GR Jr, Parikh M, Robinson C, Pramanik SN, Goins KM, Sutphin JE, Alward WL, Greenlee EC, Kwon YH, Wagoner MD. Escalation of glaucoma therapy after deep lamellar endothelial keratoplasty. *Cornea* 2010;29(9):991-995.
- 13 Musa FU, Patil S, Rafiq O, Galloway P, Ball J, Morrell A. Long-term risk of intraocular pressure elevation and glaucoma escalation after deep anterior lamellar keratoplasty. *Clin Exp Ophthalmol* 2012;40(8):780-785.
- 14 Panda A, Sethi HS, Jain M, Nindra Krishna S, Gupta AK. Deep anterior lamellar keratoplasty with phacoemulsification. *J Cataract Refract Surg* 2011;37(1):122-126.
- 15 Javadi MA, Feizi S, Moein HR. Simultaneous penetrating keratoplasty and cataract surgery. *J Ophthalmic Vis Res* 2013;8(1):39-46.
- 16 Srinivasan S, Kiire C, Lyall D. Chandelier anterior chamber endoillumination-assisted phacoemulsification in eyes with corneal opacities. *Clin Exp Ophthalmol* 2013;41(5):515-517.
- 17 Mathias MT, Oliver S, Olson J, et al. Retinal phototoxicity caused by chandelier endoillumination. *Invest Ophthalmol Vis Sci* 2010;51(13):3614.
- 18 van den Biesen PR, Berenschot T, Verdaasdonk RM, van Weelden H, van Norren D. Endoillumination during vitrectomy and phototoxicity thresholds. *Br J Ophthalmol* 2000;84(12):1372-1375.
- 19 Aydin B, Dinç E, Yilmaz SN, Altiparmak UE, Yülek F, Ertekin S, Yilmaz M, Yakın M. Retinal endoilluminator toxicity of xenon and light-emitting diode (LED) light source: rabbit model. *Cutan Ocul Toxicol* 2014;33(3):192-196.
- 20 Kleinmann G, Hoffman P, Schechtman E, Pollack A. Microscope-induced retinal phototoxicity in cataract surgery of short duration. *Ophthalmology* 2002;109(2):334-338.
- 21 Cetinkaya A, Yilmaz G, Akova YA. Photic retinopathy after cataract surgery in diabetic patients. *Retina* 2006;26(9):1021-1028.
- 22 Ataş M, Demircan S, Karatepe Haşhaş AS, Gülhan A, Zararsız G. Comparison of corneal endothelial changes following phacoemulsification with transversal and torsional phacoemulsification machines. *Int J Ophthalmol* 2014;7(5):822-827.