International Journal of Medical Ophthalmology

E-ISSN: 2663-8274
P-ISSN: 2663-8266
www.ophthalmoljournal.com
IJMO 2023; 5(1): 96-102
Received: 11-02-2023
Accepted: 16-03-2023

Osama Mohamed Saad
Ophthalmology Department, Faculty of Medicine, Tanta University, Tanta, Egypt

Amr Fawzy Sharaf
Ophthalmology Department, Faculty of Medicine, Tanta University, Tanta, Egypt

Waleed Abd Elhady Allam
Ophthalmology Department, Faculty of Medicine, Tanta University, Tanta, Egypt

Mohamed Sameh EL Shorbagy
Ophthalmology Department, Faculty of Medicine, Tanta University, Tanta, Egypt

Corresponding Author:
Osama Mohamed Saad
Ophthalmology Department, Faculty of Medicine, Tanta University, Tanta, Egypt

Clinical evaluation of Deep Anterior Lamellar Keratoplasty (DALK)

Osama Mohamed Saad, Amr Fawzy Sharaf, Waleed Abd Elhady Allam and Mohamed Sameh EL Shorbagy

DOI: https://doi.org/10.33545/26638266.2023.v5.i1b.148

Abstract
Background: Keratoconus is a progressive, non-inflammatory corneal ectasia with central thinning. The aim of this work was to evaluate intra and post-operative complications and final visual outcome of deep anterior lamellar keratoplasty (DALK).
Methods: This prospective cohort interventional study was carried out on 20 patients aged from 20 to 65 years old with superficial corneal stromal opacities based on clinical examination and AS-OCT (anterior segment optical coherence tomography), advanced keratoconus with central corneal thickness below 400 microns or the presence of scarring in the visual axis.
Results: Descemet's membrane (DM) perforation was encountered in 7 eyes attempted DALK (35%). Early epithelial defect happened in 13eyes post operatively mostly due to surgical manipulation of the grafts, 2 of them (10%) continue to the 3 months post operatively. Five eyes developed DM folds, three eyes (15%) developed Urrets-Zavalia syndrome, one eye 5% developed anterior cortical cataract, four eyes (20%) had interface haze. Best corrected visual acuity (BCVA) was affected in one case and improved in all cases with 85% of eyes achieved 0.5 or more after one year postoperative. Double anterior chamber (AC) was found in five eyes (25%). two eyes were successfully managed with single air injection.one eye needed DM Endothelial Keratoplasty. The mean recipient bed thickness was 42.850±8.869 um. Average K decreased significantly postoperatively. A low myopia was encountered at 6 months postoperatively.
Conclusions: DALK led to reasonable postoperative visual and refractive outcome, patient age, peripheral descemet's fold, failed pneumatic dissection has no significant impact on postoperative visual acuity. Risk of DM detachment, interface haze and double AC and hemorrhage during trephination are the main complications.

Keywords: Deep anterior lamellar keratoplasty, complications, visual acuity

Introduction

The cornea is a transparent structure in the anterior1/6 of the outer coat of the eye. The cornea is exposed to the atmosphere and so often suffers from injury, inflammation and infection. Corneal opacities result from processes which disturbs its anatomy and\or physiology. Any inflammation or injury is likely to cause permanent damage or scar [1].

Keratoconus (KC) is a progressive, non-inflammatory corneal ectasia with central thinning. About 10-20% of the patients eventually require penetrating keratoplasty (PKP) or deep anterior lamellar keratoplasty (DALK) due to sever thinning of the corneal stroma or scarring at the visual axis, in such cases intra corneal rings(ICRS)or rigid gas permeable contact lenses (RGPs) have a limited value to reach a reasonable visual acuity [1].

Anterior lamellar corneal grafting may be indicated in patients who present with opacities or loss of tissue that does not involve the full thickness of the cornea with a good endothelial cell function with no epithelial or stromal edema. These conditions include: superficial stromal dystrophies or degenerations that doesn't involve the Decemet's membrane (DM), superficial corneal scars, multiple recurrent pterygia, corneal thinning disorders eg: Terrien's marginal degeneration, congenital lesions e.g.: dermoid, ectatic corneal conditions e.g.: KC, Pellucid marginal degeneration and keratectasia, some degrees of chemical/thermal burns, climatic degeneration, band keratopathy and corneal clouding due to mucopolysaccharidosis. [2]

DALK does not replace damaged endothelium which severely restricts its indications. DALK also is more difficult than PKP and more time demanding and may have intra operative complications as rupture of Descemet's membrane (DM) during air injection and Perforation of the cornea during intra stromal insertion of the needle [2].

The aim of this work was to evaluate intra and post-operative complications and final visual outcome of DALK.

Patients and Methods

This prospective cohort interventional study was carried out on 20 patients aged from 20 to 65 years old, with superficial corneal stromal opacities based on clinical examination and AS-OCT (anterior segment optical coherence tomography), advanced KC with central corneal thickness below 400 microns or the presence of scarring in the visual axis.

The study was done after approval from the Ethical Committee Tanta University Hospitals from August 2019 to August 2020. An informed written consent was obtained from the patients.

Exclusion criteria were for the patient: uncontrolled diabetes and hypertension, collagen diseases or autoimmune disorders, eye lid abnormalities as blepharitis, ectropion, corneal inflammation and severe vascularization, absent corneal sensation, anterior synechiae or uveitis, uncontrolled glaucoma, endothelial dysfunction.

For the graft: corneas from infants, death of the donor due to unknown cause, certain systemic infections of the donor eg: viral hepatitis, syphilis and septicemia, intrinsic eye diseases like malignancy and active inflammations.

All patients were subjected to: history taking, clinical ophthalmic examination and investigational studies include: **b**est corrected visual acuity (BCVA) of the patient using a Snellen's chart which converted into the Logarithm of the Minimum Angle of Resolution (Log MAR) scale for statistical purposes, slit lamp examination to detect the level and the size of the opacity using TOPCON photo slit lamp (SL-2G) and for any sign denoting active inflammation or infection, full ophthalmological examination plus intra ocular pressure examination.

Pre-operative assessment of corneal thickness using optical methods either Pentacam or anterior segment optical coherence topomaphy (AS-OCT), visual Evoked Potential (VEP), Electro Retino Gram (ERG) using RETIMAX system, B scan ultra sonography (US) using BIOSOUND device.

Operative technique

One case was admitted 2weeks before the operation and partial periotomy was done to her in combined with fine needle diathermy (FND) to large interstitial corneal blood vessels encroaching the recipient's stroma. All surgeries were attempted using Anwar big bubble technique which includes: centration and marking of the cornea, partial trephination incision of about 60-70% depth of the cornea using 7.5mm Hess burg–Barron trephine, paracentesis to allow AC decompression then needle was inserted into the pre descemet's plane then air was forcefully injected causing sudden appearance of a big air bubble outlined by a white band separating the DM from the whole stroma, superficial keratotomy of the superficial layer of the cornea with crescent knife, stroma on the top of the bubble was incised by using a sharp blade by doing two long perpendicular incisions creating 4 quadrants of residual stroma then each quadrant is excised, baring the DM, only after recipient bed preparation was completed the donor tissue was prepared by punching an appropriate-sized button with a trephin, then DM was stripped off the donor graft with a forceps or Weckel sponge, graft was sutured into position using 10-0 nylon in interrupted or continuous sutures, wound cooptation was tested by injection an air bubble in the AC.

Postoperative treatment

Prednisolone acetate 1% eye drops every hour then gradual withdrawal along the duration of one month, moxifloxacin 0.5% every hour for 3 days then 5 times daily for one weak and once daily for one weak, levofloxacin 500 mg tablet once daily, tobramycin/dexamethasone ointment once at bed time for two weeks, topical intraocular pressure lowering agents according to the case.

Post-operative Evaluation

One day after the operation: To detect early post-operative complications such as: pupillary block by the bubble, wound coapation, stitches state, epithelial defect, double AC, interface bleeding and intraocular pressure evaluation (IOP).

Three days after the operation: to revise the pervious data and detect any sign of intra ocular infection.

After one weak contact lens removal.

Monthly: monitoring visual acuity and any sign of stitches loosening or infection.

After three Months: Anterior segment optical coherence topomaphy (AS-OCT) using (OCT NIDEK retino scan RS-3000) to assess the graft DM interface.

After 6 Months: start selective sutures removal.

After one year: complete sutures removal, spectacle correction and examination of final BCVA of the patient.

Keratometric measurement using Topcon autokearometer TOPCON KR 8800 after complete sutures removal.

Statistical analysis

Statistical analysis was done by SPSS v20. Quantitative variables were presented as mean and standard deviation (SD) and were compared by paired Student's t- test for the same group. Qualitative variables were presented as frequency and percentage (%). A two tailed P value < 0.05 was considered significant.

Results

The mean age of patients at the time of the operation was 30±12 years. DM perforation occurred in 9 eyes attempted DALK (40.91%).5 eyes during trephination and 4 eyes during air injection. Table 1

Table 1: Gender distribution, preoperative diagnosis and operative details of the study cases and DM perforation timing in all cases (n=9/23-39.13%)

N (%)		
Sex	**Male**	6 (30%)
	Female	14 (70%)
Pre-operative Diagnosis	Advanced Keratoconus	15 (75%)
	Post Lasik ectesia	2(10%)
	Pellucid marginal degeneration	1(5%)
	Post viral opacity	1(5%)
	Macular dystrophy	1(5%)
Dissection Type	Successful big bubble formation	17 (85%)
	Failed bubble formation	3(15%)
Bubble type	Type I	16(80%)
	Type II	1(5%)
Suture type	Interrupted	19(95%)
	Continuous	1(5%)
DM perforation (n=9/23- 39.13%)	During trephination	5(21.74%)
	During intra stromal air injection	4(17.39%)

Data are presented as frequency (%). DM: Descemet's membrane

Early post-operative findings and post-operative complications are shown in Table 2

Table 2: Early post-operative findings and post-operative complications

	N (%)	
Early post op visit	Epithelial defect	13(65%)
	AC bubble	19(95%)
	Graft edema	8(40%)
	DM folds	5(25%)
	IOP	1(5%)
	Double AC	5(25%)
	Interface haze	4(20%)
	AC reaction	1(5%)
	Graft interface hemorrhage	1(5%)
	High IOP	1(5%)
	UZ syndrome	3(15%)
	Persistent double AC	3(15%)
Post op	DM folds	5(25%)
	Persistent epithelial defect	2(10%)
	Cataract	1(5%)
	Epithelial rejection	0
	stromal rejection	0
	Intra stromal haze	4(20%)
	Interface infiltration	2(10%)
	Intra stromal derpits	1(5%)
	Sutures loosening	1(5%)
	Sutures infiltration	1(5%)
	Sutures infection	0
	Sutures vascularization	1(5%)
	Persistent interface haze	4(20%)
	Graft/ Interface infection	1(5%)

Data are presented as frequency (%). IOP: Intra Ocular Pressure UZ: Urrets-Zavalia syndrome AC: Anterior chamber. Post-operative Visual acuity progression are shown in Table 3

Table 3: Post-operative Visual acuity progression

Time	VA	COMP.	Differences	t	P-value
Preoperative	1.240±0.497	-	-		
Post 1 Month	0.912±0.529	P-1M	0.328±0.664	2.209	0.040*
Post 2 Months	0.796±0.556	P-2M	0.444±0.704	2.819	0.011*
Post 3 Months	0.723±0.560	P-3M	0.517±0.701	3.300	0.004*
Post 6 Months	0.601±0.293	P-6M	0.640±0.568	5.034	<0.001*
After stitch removal	0.515±0.326	P-S	0.726±0.573	5.657	<0.001*
BCVA	0.377±0.356	P-G	0.864±0.569	6.782	<0.001*

Data are presented as mean ± SD, * statistically significant. BCVA: Best Corrected Visual Acuity.

Final BCVA was ranging from 0.1 to1.6 log MAR with mean 0.37±0.35log MAR (0.5 decimal) and this show increase with 0.864±0.569 as compared to preoperative BCVA. Table 4

Table 4: Compared to preoperative BCVA to post-operative BCVA, Anterior Segment OCT Data, k1 data analysis, Mean K2, Corneal mean k reading (Keratometric)

Time			Differences	t	P-value
BCVA	Preoperative	1.240±0.497	0.864±0.569	6.782	<0.001*
	Post Glasses	0.377±0.356			
Thinnest location	Preoperative	341.950±73.755	-184.850±91.551	-9.030	<0.001*
	Post-operative	526.800±74.411			
K1	Preoperative	54.800±7.142	12.990±6.945	8.365	<0.001*
	Post-operative	41.810±2.292			
K2	Preoperative	60.395±7.622	16.183±7.973	9.077	<0.001*
	Post-operative	44.213±2.339			
KM	Preoperative	57.598±7.006	14.586±7.011	9.304	<0.001*
	Post-operative	43.012±2.207			

Data are presented as mean ± SD, * statistically significant.

Examples of cases are shown in figure 1, 2, 3

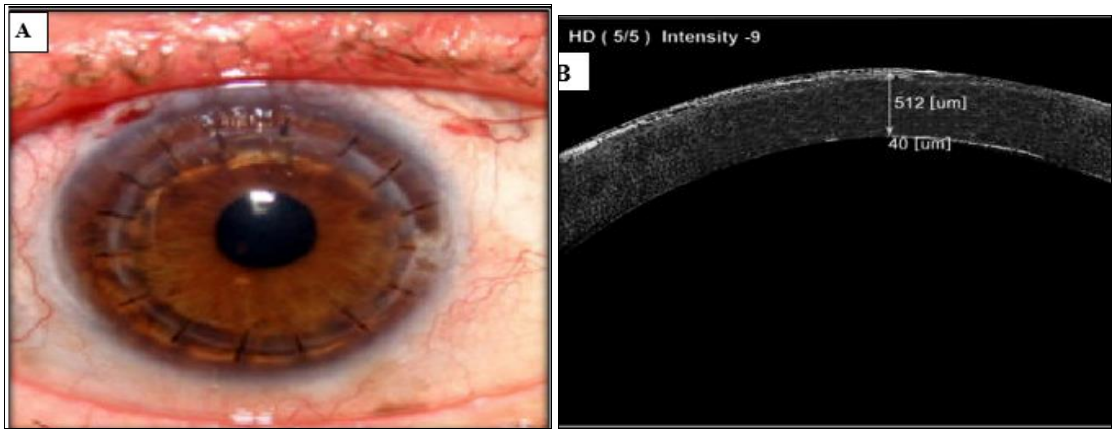

Fig 1: (A)Three months post-operative, (B) AS-OCT of the case 3 months post-operative

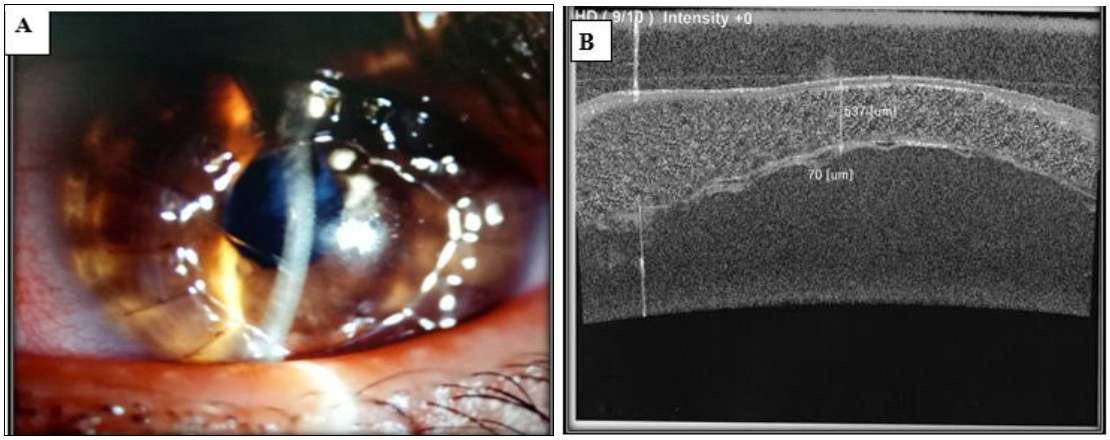

Fig 2(A): Three months post-operative show area of DM folds(B) One weak post-operative AS-OCT show areas of DM detachment and folds, the case was managed by air bubble injection

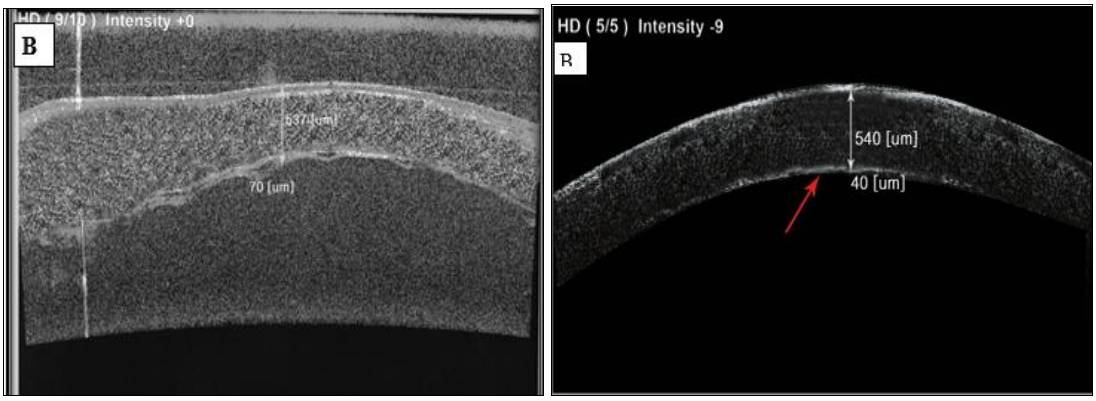

Fig 3(A): Three months post-operative of a case done by manual dissection show mild interface haze (this case injected intra cameral air for DM detachment).(B) AS-OCT (3months post-operative) shows minimal interface haze

Discussion

In the present study, failed big bubble formation was happened in 3 eyes (15%) one of them had pre-operative corneal scar, the second eye had a very thin cornea with pre-operative central corneal thickness 315um, and the last eye had large DM perforation during trephination. This agreed with a study done by Borderie *et al.* [3] Who reported that slow trephination and absence of posterior stromal scarring increase the chance of successful big bubble formation. In such cases manual dissection was performed in the central 6 mm of the host stroma to reach as close as possible to the DM level.

In the present study DM perforation was encountered in 9 eyes attempted DALK (39.9.91%) 5 eyes during trephination, 4 eyes during air injection. Two cases were converted to PKP and excluded from the study and 7eyes (77%) were completed as DALK.

The rate of intraoperative conversion from DALK to PKP was variable among studies and reached up to 30% in previous studies [4] As well as the main cause of intraoperative conversion to PKP was (DM) large perforation during trephination that failed to be managed. Fortunately, DM perforation doesn't mandate conversion to PKP in all cases, from 9 eyes in our study 7 eyes (77%) had completed as DALK after intraoperative DM perforation either by rebulbing, suturing the perforated area, intra cameral air bubble injection or complete the case by manual dissection in case of failed bubble formation.

Leccisotti A *et al*. [5] reported that 55% of DM perforations were micro perforations and DALK could be completed by manual dissection.

Sarnicola *et al*. 2011 [6] reported that after one year of follow up the most common complication of Anwar' s technique was micro and macro perforations. Rupture of DM occurred in 25 of 236 eyes (11%), seven eyes of 236 (3%) were macro perforations and converted to PKP, while the remaining 18 of 236 eyes (8%) were micro perforations and air was injected intra cameral and the surgery was completed as DALK.

Arslan *et al*. 2011 [7] He mentioned that 4 eyes (5%) were converted into PKP intraoperative because of DM macro perforations. Micro perforations in the DM occurred in 9 eyes, these eyes were completed successfully with the help of air injection into the AC.

Interrupted sutures had shown to be associated with increased astigmatism than continuous sutures. However, after selective suture removal astigmatism and BCVA were found to be nearly comparable. In present study, only one eye had interrupted sutures and developed reasonable post-operative spherical equivalent was (-2.5) D.

Previous studies [8, 9] showed that early sutures removal (before 12 months) could lead to wound gapping, unpredictable refraction and marked increased post-operative myopia and astigmatism.

In the current study sutures started to be removed 6 months postoperative and complete suture removal was done after one year, also early epithelial defect was happened in13 eyes post operatively due to surgical manipulation of the graft, two of them (10%) persisted for 3 months post operatively.

Previous studies [10, 11] reported that incidence of DM folds after DALK was about 30% which was matched with our results. This arising from compression of the redundant host DM on the donor graft or mismatching between the donor graft size and recipient bed. Folds usually didn't affect the visual outcome, but when they involved the visual axis they may cause visual disturbances. The risk factors for DM folds included age older than 20 years and disease duration longer than 5.5 years. The steeped wound configuration and Clearance of only central 6 mm of the predescematic layer was found to decrease the incidence of DM folds in advanced cases of KC particularly.

In the present study The incidence of double AC was 25% (five eyes) which is high in comparison to previous reports [12, 13] Three eyes of them developed micro perforation in the DM during surgery, two were complete to DALK with rebulbing and one eye by manual dissection. Two eyes attached spontaneously. Other two eyes were successfully managed with single air injection and one eye developed persistent double AC and was prepared for DMEK (DM endothelial keratoplasty) after three months.

Anwar [14] reported that DM detachment had been occurred once in a series of 100 cases (1%), for which single air injection intra cameral 3 weeks after the operation.

Dena *et al.* [15] reported that postoperative pseudo-AC formation was observed in 60% of the perforated eyes which was significantly higher than that observed in the imperforated eyes.

Three eyes (15%) developed UZ (Urrets-zavailia) syndrome. Previous studies [16] reported that 7.8% of eyes developed fixed dilated pupils; this was more common after keratoplasty for KC.

In the current study One eye (5%) developed anterior cortical cataract that could to be attributed to air filling of the AC during surgery. A previous study [17] reported complicated cataract in 8% of eyes after DALK and 19% of eyes after PKP.

In a study by Feizi *et al.* [18] on 129 eye; Graft rejection reaction consisting of subepithelial and stroma rejection occurred in 14.3% of the eyes. The majority of graft rejection episodes occurred in the first year after surgery. Javad *et al.* [19] reported that Immunological graft rejection episodes occurred in (12%) of the cases. He reported that epithelial rejection episode were diagnosed 4 months after the operation with presence of decreased vision, and sub epithelial infiltrates without stromal edema. Cases responded well to intensive topical corticosteroids (betamethasone) and the graft became clear after 1-2 weeks of treatment.

Noble *et al.* [4] reported complications of DALK performed in 58 eyes suffering from KC. Rejection episodes occurred in 9.6% of the eyes but were successfully reversed in all eyes. Graft failure occurred in one eye with sever stem cell deficiency.

In the present study a low myopia was encountered after 6 months postoperatively this agreed with previous studies reported that using nearly the same size donor and recipient graft size results in low myopia (difference 0.25mm). The mean spherical equivalent was -2.600±1.496 D also, the mean recipient bed thickness was 42.850 ±8.869 um and average K decreased significantly from 57.598±14.586 to 43.012±2.207 post operatively by 14.586±9.304. In a study that involved performing manual dissection DALK for eyes with herpetic stromal scars the average recipient bed thickness was 114 um [20] reported that mean topographic keratometry (MK) changed from 50.06±3.965 D preoperatively to 42.34 ± 2.356 D postoperatively.

In the present study all cases showed improvement in the BCV up to 0.8 (by decimal) in 20% of the cases and 0.6 in20% of the cases 0.4 in 25% of the cases except one case complicated by graft infection which led to post-operative graft thinning and fibrosis. This agrees with previous studies. This improvement could be explained by removal of the visual obstacle in cases with stromal opacity and

reduction of irregular astigmatism (corneal asymmetry) in cases with KC [21]

Bahar *et al*. [22] reported that mean BCVA after 12 months was 0.5. Silva *et al*. [23] reported that BCVA in DALK group was o.6 in 40% of the cases, 0.8 in 40% of the cases. Noble *et al*. [4] reported visual outcome of DALK performed in 58 eyes suffering from KC as follow: BCVA of 8.0 was present in 24.7%, 0.6 or better in 69.9% of the cases. Arslan *et al*. [7] reported that 65 eyes (82.3%) reached a BCVA better than or equal to o.5 Anther a study by Feizi *et al*. [18]**.** studied the outcomes of DALK in patients with KC using big bubble technique, the study reported that BCVA >0.5 was achieved in 77.8% of eyes after the operation. These all results nearly matched with our study results.

In the current study 4 eyes (20%) developed interface haze, 2 eyes of them were done by manual dissection one of them developed graft interface infection, another eye developed intra operative hemorrhage due to injury of vascularized scar during trephination that cause post-operative hemorrhage in the graft recipient interface. Fontana *et al*. reported that graft-host interface opacities occurred in 43% of eyes [13].

Previous studies [24] reported that eyes which was done by manual dissection developed low visual outcome than eyes done with successful big bubble. In the current study there was no significant difference in BCVA despite the thickness of recipient bed was slightly higher in eyes with manual dissection except one eye showed gross Descemet's folds encroaching the visual axis. Theses similar results between manual dissection and big bubble mostly attributed to performing dissection as deep as possible rendering manual DALK comparable to bubble DALK.

It was recommended that DALK should be considered surgical operation of choice for corneal ectasia and superfical stromal opacity with healthy endothelium, using a large diameter graft with early suture removal should be considered to improve the refractive results and further research is required to improve the technique and make it more repeatable, more endothelial-friendly and overcome complications.

Conclusions

DALK led to reasonable postoperative visual and refractive outcome, patient age, peripheral Descemet's fold, failed pneumatic dissection has no significant impact on postoperative visual acuity. Risk of DM detachment, interface haze and double AC and hemorrhage during trephination are the main complications.

Financial support and sponsorship: Nil

Conflict of Interest: Nil

References

1. Ashaye A, Oluleye T. Pattern of corneal opacity in Ibadan, Nigeria. Ann Afr Med. 2004;3:185-7.
2. Wagoner M, Ba-Abbad R, Al-Mohaimeed M, Al-Swailem S, Zimmerman M. King Khaled Eye Specialist Hospital Corneal Transplant Study Group Postoperative complications after primary adult optical penetrating keratoplasty: prevalence and impact on graft survival. Cornea. 2009;28:385-94.
3. Borderie VM, Touhami S, Georgeon C, Sandali O. Predictive factors for successful type 1 big bubble during deep anterior lamellar keratoplasty. J Ophthalmol. 2018;2018:112-15.
4. Noble BA, Agrawal A, Collins C, Saldana M, Brogden PR, Zuberbuhler B. Deep anterior lamellar keratoplasty (DALK): visual outcome and complications for a heterogeneous group of corneal pathologies. Cornea. 2007;26:59-64.
5. Leccisotti A. Descemet's membrane perforation during deep anterior lamellar keratoplasty: prognosis. J Cataract Refract Surg. 2007;33:825-9.
6. Sarnicola V, Toro P. Blunt cannula for descemetic deep anterior lamellar keratoplasty. Cornea. 2011;30:895-8.
7. Arslan OS, Ünal M, Tuncer I, Yücel I. Deep anterior lamellar keratoplasty using big-bubble technique for treatment of corneal stromal scars. Cornea. 2011;30:629-33.
8. 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;37:39-44.
9. Mannan R, Jhanji V, Sharma N, Pruthi A, Vajpayee RB. Spontaneous wound dehiscence after early suture removal after deep anterior lamellar keratoplasty. Eye Contact Lens. 2011;37:109-11.
10. Li X, Zhao Y, Chen H, Li Y, Hong J, Xu J. Clinical properties and risk factors for Descemet membrane folds after deep anterior lamellar keratoplasty in patients with keratoconus. Cornea. 2019;38:1222-7.
11. Suzuki N, Yamaguchi T, Tomida D, Tsubota K, Shimazaki J. Impact of corneal higher-order aberrations on visual acuity after deep anterior lamellar keratoplasty in treating keratoconus. Eye Contact Lens. 2019;45:238-45.
12. El Sayed SH, Ismail MM, El Sawy MF, El Hagaa AA, Aziz MSA. The visual outcome and complications in deep anterior lamellar keratoplasty for keratoconus. Menoufia Med J. 2016;29:587-92.
13. Fontana L, Parente G, Tassinari G. Clinical outcomes after deep anterior lamellar keratoplasty using the big-bubble technique in patients with Keratoconus. Am J Ophthalmol. 2007;143:117-24.
14. Anwar HM, El-Danasoury A, Hashem AN. The use of fibrin glue to seal Descemet membrane micro perforations occurring during deep anterior lamellar keratoplasty. Cornea. 2012;31:1193-6.
15. Den S, Shimmura S, Tsubota K, Shimazaki J. Impact of the descemet membrane perforation on surgical outcomes after deep lamellar keratoplasty. Am J Ophthalmol. 2007;143:750-4.
16. Davies P, Ruben M. The paretic pupil: its incidence and aetiology after keratoplasty for keratoconus. Br J Ophthalmol. 1975;59:223-8.
17. Khattak A, Nakhli FR, Al-Arfaj KM, Cheema AA. Comparison of outcomes and complications of deep anterior lamellar keratoplasty and penetrating keratoplasty performed in a large group of patients with keratoconus. Int. Ophthalmol. 2018;38:985-92.
18. Feizi S, Javadi MA, Jamali H, Mirbabaee F. Deep anterior lamellar keratoplasty in patients with keratoconus: big-bubble technique. Cornea. 2010;29:177-82.
19. Javadi M-A, Feizi S, Jamali H, Mirbabaee F. Deep anterior lamellar keratoplasty using the big-bubble technique in keratoconus. J Ophthalmic Vis Res. 2009;4:8-15.
20. Liu X, Zhou Q, Huang X, Liu Z, Bi Y. Clinical evaluation of deep anterior lamellar keratoplasty using glycerol-cryopreserved corneal tissues for refractory herpetic stromal keratitis: An observational study.

Medicine. 2016;95.
21. Koçluk Y, Sukgen EA, Burcu A. Comparison of outcomes in patients who underwent deep anterior lamellar keratoplasty and those converted to penetrating keratoplasty. Turk J Ophthalmol. 2017;47:63-71.
22. Bahar I, Kaiserman I, Srinivasan S, Ya-Ping J, Slomovic AR, Rootman DS. Comparison of three different techniques of corneal transplantation for keratoconus. Am J Ophthalmol. 2008;146:905-12.
23. Silva CA, Schweitzer de Oliveira E, Souza de Sena Júnior MP, Barbosa de Sousa L. Contrast sensitivity in deep anterior lamellar keratoplasty versus penetrating keratoplasty. Clinics (Sao Paulo). 2007;62:705-8.
24. Fontana L, Parente G, Sincich A, Tassinari G. Influence of graft–host interface on the quality of vision after deep anterior lamellar keratoplasty in patients with keratoconus. Cornea. 2011;30:497-502.

How to Cite This Article
Patil M, Gitanjali M. Combined small incision cataract surgery and trabeculectomy on intra ocular pressure outcome. International Journal of Medical Ophthalmology. Yy;vol(issue):pp.