Descemet's Stripping Endothelial Keratoplasty: An Update

Dr Ashok Sharma- MS, Dr Rajan Sharma - MBBS
Cornea Centre, Chandigarh

Corneal transplant is the most successful of all the organ transplants being performed on the human body. First successful human corneal transplant was performed by Dr Zirm in 1906. Since then large number of corneal surgeons contributed to the improvement of the surgical procedure and success rate of the corneal transplants. In good prognosis cases the success rate of the procedure is 90% to 95%. Corneal surgeons still face problems of allograft rejection, post-keratoplasty astigmatism and suture related complications.[1] By the time the procedure achieved a landmark of 100 years after first successful corneal transplant, several newer lamellar procedures were evolved. The concept of component therapy for management of corneal disorders was introduced. In addition to the deep anterior lamellar keratoplasty (DALK), the concept of posterior lamellar keratoplasty was introduced. Since then number of newer surgical procedures have been introduced. Research is still going on to further take care of some of the problems associated with these newer procedures.

A Posterior lamellar keratoplasty:

This procedure was introduced by Gerrit Melles; MD[2] In this procedure lamellar dissection of the host cornea at the level of anterior two-third and posterior one- third is performed. Intrastromal trephination is performed using special corneal trephine and posterior corneal disc is removed. In the same way intra-stromal dissection of the donor cornea is performed after mounting the donor cornea onto the artificial anterior chamber. The donor disc is punched from the endothelial side and is placed in the host cornea. Later Mark Terry, MD used viscoelastic substance to dissect deeper layers and termed his technique deep lamellar endothelial keratoplasty (DLEK). [3] The procedure has a steep learning curve. It is also associated with primary graft failure, donor disc dislocation and host versus donor mismatched thickness. Because of technical difficulties and associated complications the procedure is no longer performed.

B Descmet's Stripping Endothelial Keratoplasty (DSEK):

DSEK procedure was described by Gerrit Melles.[4] In this procedure the manual dissection of the corneal stroma was avoided. Instead Descemet's membrane is stripped from the posterior cornea using DM stripper or reversed Sinskey hook (Bausch and Lomb, St. Louis, MO). Trephine mark is put on the anterior surface of the cornea and this serves as a guide to complete DM stripping. To facilitate the visualization of the Descemet's membrane it may be stained with Trypan blue dye. To enhance the visualization of the DM, the edematous corneal epithelium should also be scraped off.

Donor cornea (14 mm diameter) is placed on the artificial anterior chamber. Anterior stromal trephination up to 350 micron meter is performed. Lamellar dissection of the donor cornea is completed and donor disc is punched out from the endothelium side. The donor disc contains endothelium, Descemet's membrane and posterior stroma (150 micron meter). Lamellar dissection of the donor cornea should be performed carefully to avoid button holing, Descemet's membrane perforation, irregular thickness of donor disc and incomplete dissection.

The anterior chamber is cleared off any viscoelastic substance. Viscoelastic substance is put on the endothelial side of the donor disc. The donor disc is folded 60:40 ratio and held with the help of a special forceps. The donor disc is inserted into the anterior chamber. The insertion should be smooth and least traumatic. After insertion of the donor disc, it is unfolded using an air bubble. Once the donor disc adhered to the posterior corneal surface it is centered over the pupil. Main incision and the side port entries are closed. An intra-operative inferior peripheral iridectomy is performed to avoid papillary block glaucoma(Fig 1).

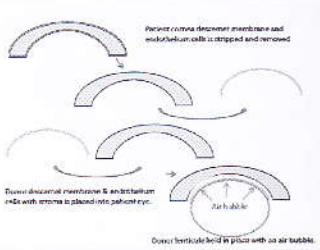

Fig.1: DSAEK diagrammatic representation

Corneal surgeon in the initial phase may select Fuchs' dystrophy or pseudophakic corneal edema with good visualization and normal anterior chamber(Fig 2,3). However the experienced corneal surgeons perform DSEK / DSAEK in patients with anterior chamber IOLs, aphakia, graft failure and glaucoma with filtering surgery (AGV).

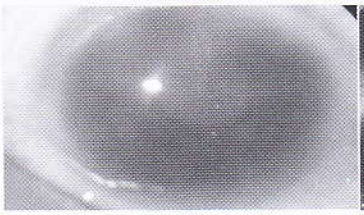

Fig. 2: Fuch,s endothelial dystrophy

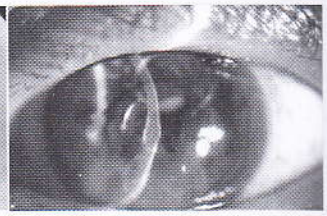

Fig. 3: Pseudophakic corneal edema

The DSEK / DSAEK procedure may be combined with phaco emulsification or sclera fixation of PCIOL.

C Descemet's Striping Automated Endothelial Keratoplasty (DSAEK):

Currently DSAEK is the most common endothelial keratoplasty procedure being performed. In DSAEK the surgical procedure essentially remains the same as in DSEK. The only difference is that the manual dissection of the donor cornea to obtain donor disc is avoided. Instead a microkeratome with 350 micron meter head is used to remove the stroma and finally donor disc is punched from the endothelial side. The donor graft preparation with microkeratome is best done by an experienced eye bank technician. Visual acuity has been reported better with DSAEK as compared to DSEK. In some of the patients whose visual acuity did not improve following DSEK, improved significantly following DSAEK, as the dissection with microkeratome is smoother than the manual dissection.

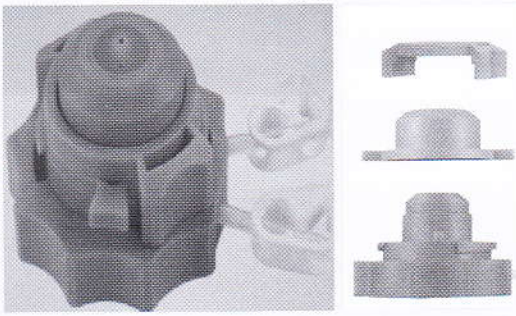

Fig. 4&5 Parts of artificial anterior chamber (Katena)

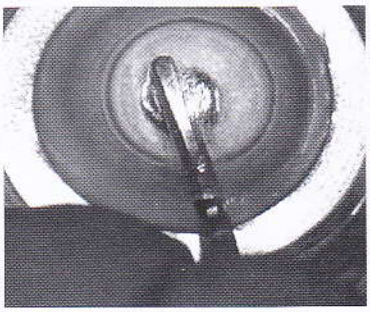

Fig. 6 Mannual lamellar dissection in DSEK

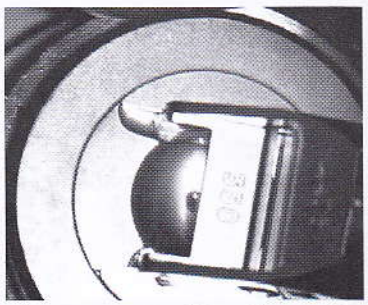

Fig. 7 Automated lamellar cutting of donor button in DSAEK

Details of the artificial anterior chamber and some surgical steps are shown in figs. 4 to 7.

Donor lenticule preparation

Microkeratome: The donor corneoscleral rim is mounted on the artificial anterior chamber. Microkeratome is adjusted to cut the anterior 350 micron stroma. IOP in the artificial anterior chamber is kept under control. Higher IOP yields thinner donor lenticule. The thinner lenticules may also be obtained by slower passes. Donor graft thickness asymmetry and irregular surface may cause postoperative

hyperopic shift. Smoothening of the irregular surface using excimer laser is currently under evaluation.

D Ultra-thin DSAEK:

Ultra thin DSAEK has been reported to enhance visual acuity results. Most corneal surgeons believe 100 micron thickness as ultra thin lenticule. However in several studies in donor lenticule of 130 micron has been considered an ultra- thin. A double pass microkeratome technique has been used to prepare ultra-thin DSAEK lenticule.[5] This technique provides thin lenticule, but increases the risk of corneal perforation and endothelial cell loss. Stromal hydration technique by injecting BSS into corneal stroma or keeping the corneo-scleral tissue in hypo-osmotic tissue culture medium have also been used to get ultrathin tissue.[6] Currently most surgeons prefer single pass technique. Busin et al have reported that visual outcome following UT DSAEK is better than conventional DSAEK and comparable to DMEK.[6] In recent publications use of DSAEK grafts sub 100 micron thickness have been used with bood visual outcome. In our experience UT DSAEK may be performed with more ease and predictable manner with the use of endosaver.

Femtosecend laser:

Femtosecond laser can be used to cut lamellar donor disc to perform DSEK. After femtosecond laser cut the donor disc is separated with the help of spatula. Femtosecond laser has also been used to aim smoother surface of donor lenticule. Studies have shown that femtosecond prepared tissues have more irregularities, rough stromal beds and increased thickness irregularity compared to microkeratome prepared tissue.[7] The irregularities in to the stromal surface have been attributed to comparison and deformation of cornea by femtoscend laser applanation cone.

Insertion techniques:

Several techniques including taco fold (60:40), use of Busin,s glide and simple glide have been described (Figs 8,9). After taco fold the disc is inserted with the help of specially designed forceps. Significant endothelial cell loss has been reported with the use of forceps. Endothelial cell loss is more in the initial cases due to learning curve. A recent study reviewed three surgical techniques, forceps assisted insertion of a 60-40 folded donor disc (taco), forceps assisted pulling and needle assisted pushing of the donor graft. Endothelial cell loss was comparable in all the three techniques.

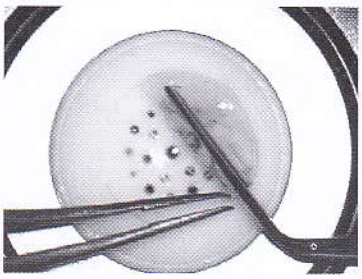

Fig. 8 Folding of donor disc (60:40)

Fig.9 Busin Glide

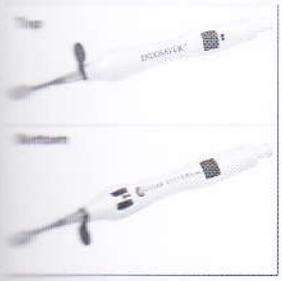

Fig. 10 Endosaver

Use of donor insertion device (EndoGlide) resulted lower endothelial cell loss compared to sheet glide.[8] Use of Busin glide has been reported to provide better endothelial cell survival following DSAEK.[9] Endosaver is another device commonly used to insert the donor disc in DSAEK.[10] The endosaver is user friendly and enhances endothelial cell survival. The insertion device has an irrigation system that keeps the anterior chamber deep during insertion of donor disc (Fig 10). In addition to the insertion technique, the incision size is also known to affect endotheial cell survival in DSAEK. In a comparative study 5 mm incisions have been reported to provide higher endothelial cell survival compared to 3 mm incisions.[11]

Complications:

Donor disc dislocation is a common complication after DSAEK. Dislocation of donor disc usually

occurs in the immediate post operative period i.e. within a week of surgery. Late dislocations have also been reported. The average dislocation rate 14.5% (range 0 – 82%) has been reported. Primary graft failure i.e. donor graft not clearing within 2 months of surgery is another complication. Compromised endothelium, blood in the interface, shallow anterior chamber and poor surgical technique may be responsible for primary graft failure. The average graft failure rate reported is 5% (0 – 29%). The corneal endothelial cell loss is higher following DSAEK compared to PK in the first year after surgery. The mean endothelial cell loss following PK ranged 11% to 29% at 2 to 6 months, 16% to 45% at 12 months and 29% to 54% at 24 months. Mean endothelial cell loss following DSAEK ranged from 25% to 54% at 6 months and 29 to 61% at 12 months.[12] Corneal allograft rejection has been reported in 10% of cases following DSEK/DSAEK. The incidence of endothelial rejection following DSAEK is lower than following PKP.[12] Glaucoma following DSAEK may occur during immediate post operative period or few months after surgery. Immediate post surgery, acute rise of IOP is due to pupillary block caused by air bubble in the anterior chamber. This may require topical and systemic anti-glaucoma medication and release of air by opening the paracentesis site. Late onset glaucoma may be due to corticosteroid use and may need anti-glaucoma medication.[12] Epithelial downgrowth, calcareous degeneration, refractile particles at interface and air bubble induced damage to the corneal endothelium have also been reported following DSAEK.[13] Anterior segment OCT and confocal microscopic evaluation is necessary in case improvement of visual acuity is suboptimal.

Early visual rehabilitation, minimal astigmatism and no suture related complications are advantages of DSAEK procedure over the conventional penetrating keratoplasty.[12] Donor disc dislocation, primary graft failure and rise of intraocular pressure are common complications observed during early post operative period. Several modifications including anterior chamber maintainer, stab incisions for interface fluid, preoperative or intra operative inferior peripheral iridectomies decompression of anterior chamber after 1 hour and scraping of peripheral recipient bed have been advocated for decreasing the incidence of complications. DSAEK may be performed as suture less procedure (Fig 11).

Fig. 11a DSAEK Post op at 48 hours.

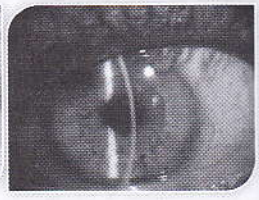

Fig. 11b DSAEK Post op at 3 week.

Fig. 12a DSEK with pupilloplasty Post op at 48 hours.

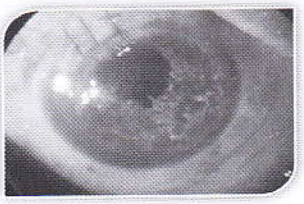

Fig. 12b DSEK with pupilloplasty Post op at 3 week.

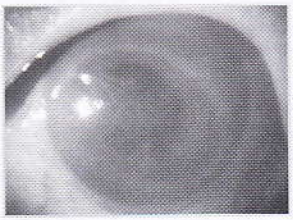

Fig. 13a Aphakic corneal edema.

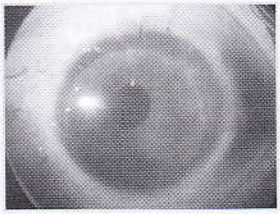

Fig. 13b DSEK with Scleral Fixated PCIOL (Combined).

DSAEK may be combined with pupilloplasty or sclera fixated PCIOL implant (Figs 12,13).

A traumatic insertion of the donor lenticule results, minimal endothelial cell loss and enhances the graft survival following DSAEK (Fig 14).

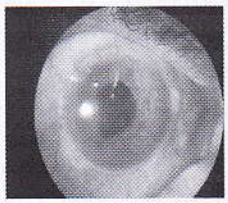

Fig. 14 DSEK after 5 years

D Descmet's Membrane Endothelial Keratoplasty (DMEK):

In DMEK transplantation of Descmet's membrane and endothelium is performed (Fig 15). Descemet's membrane is stripped from the donor cornea and injected into the anterior chamber using injector used to implant foldable IOLs. Descemet's membrane is unfolded by injecting an air bubble. It is difficult to recognize endothelial side. To identify endothelial side and to obtain optimum approximation endothelial side may be stained with trpan blue. In DMEK, the challenge is to prepare delicate graft tissue with least trauma. Several techniques to harvest the donor tissue for DMEK have been described. Melles et al described a manual technique, in which the donor corneoscleral rim is immersed in BSS and DM is pealed with one point non-toothed forceps.[14] Endothelial cell loss ranging from 4% to 7% has been reported using this technique. Giebel and Price described SCUBA (submerged corneas using backgrounds away) technique.[15] In this technique the donor cornea is submerged in the Optisol or BSS to decrease the surface tension and allows the DM to rest onto the stroma. Kruse et al harvested donor graft using a pair of forceps and reported 1% endothelial cell loss. [16] In a comparative study with DSAEK, DMEK provided better visual recovery and comparable endothelial cell loss at 6-month follow up. The DMEK group had a higher, percentage of re bubbling procedure but the difference was not statistically significant.[17]

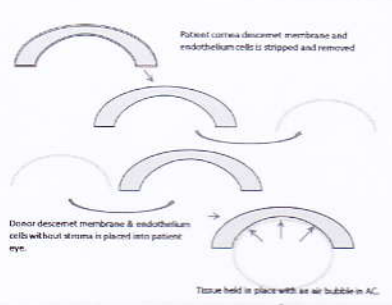

Fig. 15 DMEK diagrammatic representation

Yoereuk et al evaluated clinical outcomes of DMEK in vitrectomized eyes and found it successful in restoring visual acuity in these eyes, however the higher rate of complications was observed than the reported with standard DMEK.[18]

E ROCK Inhibitor:

Corneal endothelial decompensation in Fuchs dystrophy and pseudophakic corneal edema results in significant decrease in visual acuity. The Gold Standard treatment option for corneal decompensation remains the corneal transplant. Alternative options including hypertonic saline (5%), anterior stromal puncture, amniotic membrane transplantation, phototherapeutic keratectomy and bandage contact lenses have been advocated for symptomatic relief for patients with poor visual potential.[19] Recent experimental and human studies have reported corneal endothelial cell regeneration using Rho associated kinase inhibitor (ROCK). ROCK inhibitor Y-27632 has been documented to promote cell adhesion, proliferation and modulate apotosis in primate corneal endothelial cells in culture. [20,21] The addition of ROCK inhibitor in the culture media has also been shown to enhance the results of human corneal endothelial cell cultures. The use of a ROCK inhibitor, as intra-cameral injection for cultivated endothelial cells and as a topical eye drops, may prove to be an effective option for the treatment of corneal endothelial disorders in future.

In a comparative study DSAEK was performed in the contra lateral of the eyes those have undergone PKP.[6] In a direct comparison better uncorrected visual acuity, best-corrected visual acuity, contrast acuity, in addition to elimination of surgery-induced astigmatism and HOA were major advantages of DSAEK technique.[22] A steep learning curve, high per operative endothelial cell loss and costly equipment for cutting the donor disc are major constraints in performing DSAEK. Long term graft survival is another area of concern. In some of the studies 90% graft survival at 1 year has been reported. DMEK has the potential to achieve visual acuity equivalent or better than 20/25 in 75% (higher than DSAEK) of patients at 1-3

months.[23] In future, once the technique is standardized, corneal surgeons may prefer DMK over DSAEK. Both DSAEK and DMEK allow to benefit more than one patient from single donor cornea. DSAEK or DMEK and DALK can be performed using one donor cornea to benefit two patients.

Conclusions:

DSEK appears to be safe and effective for the management of the diseases affecting endothelium of the cornea. Surgical complication rates, graft clarity, visual acuity and endothelial cell loss following Descemet's stripping (automated) endothelial keratoplasty has been reported equivalent to PK. DSAEK has been reported superior to PK considering early visual recovery , refractive stability, postoperative refractive outcomes, wound /suture-related complications and intraoperative or late choroidal hemorrhage. DSEK/DSAEK is currently the most preferred surgical procedure for treatment of the corneal endothelial disorders. DMEK an emerging technique is technically demanding and more studies will ascertain its future.

References:

1 Dandona L, Naduvilath TJ, Janarthanan M, Raghu K, Rao GN. Survival analysis and visual outcome in a large series of corneal transplants in India. Br J Ophthalmol 1997;81:726-31.

2 Melles GR, Eggink FA, Lander F, et al. A surgical technique for posterior lamellar keratoplasty. Cornea 1998;17:618-26.

3 Terry MA, Ousley PJ. Deep lamellar endothelial keratoplasty in the first United States patients: early clinical results. Cornea 2001;20:239-43.

4 Melles GR, Wijdh RH, Nienwendaal CP. A technique to excise the Descemet's membrane from a recipient cornea. Cornea.2004;23:286-8.

5 Hsu M, Hereth WL, Moshirfar M. Double-pass microkeratome technique forultra-thin graft preparation in Descemet's stripping automated endothelialkeratoplasty. Clin Ophthalmol. 2012;6:425-32.

6 Busin M, Patel AK, Scorcia V, Ponzin D. Microkeratome-assisted preparation of ultrathin grafts for descemet stripping automated endothelial keratoplasty.Invest Ophthalmol Vis Sci. 2012;31;53:521-4.

7 Phillips PM, Phillips LJ, Saad HA, Terry MA, Stolz DB, Stoeger C, Franks J, Davis-Boozer D. "Ultrathin" DSAEK tissue prepared with a low-pulse energy, high-frequency femtosecond laser. Cornea. 2013;32:81-6.

8 Ang M, Saroj L, Htoon HM, Kiew S, Mehta JS, Tan D. Comparison of a donor insertion device to sheets glide in Descemet stripping endothelial keratoplasty: 3-year outcomes. Am J Ophthalmol. 2014;157:1163-1169.

9 Busin M, Bhatt PR, Scorcia V. A modified technique for descemet membrane stripping automated endothelial keratoplasty to minimize endothelial cell loss. Arch Ophthalmol. 2008 ;126:1133-7.

10 Borderie VM, Georgeon C, Bouheraoua N. [Influence of surgical technique on graft and endothelial survival in endothelial keratoplasty]. J Fr Ophtalmol. 2014;37:675-81.

11 Terry MA, Saad HA, Shamie N, Chen ES, Phillips PM, Friend DJ, Holiman JD,Stoeger C.

Endothelial keratoplasty: the influence of insertion techniques and incision size on donor endothelial survival. Cornea. 2009;28:24-31.

12 Lee WB, Jacobs DS, Musch DC, Kaufman SC, Reinhart WJ, Shtein RM. Descemet's stripping endothelial keratoplasty: safety and outcomes: a report by the American Academy of Ophthalmology. Ophthalmology. 2009;116:1818-30.

13 Hong A, Caldwell MC, Kuo AN, Afshari NA. Air bubble-associated endothelial trauma in descemet stripping automated endothelial keratoplasty. Am J Ophthalmol 2009;148:256-9.

14 Melles GR, Lander F, Rietveld FJ. Transplantation of Descemet's membrane carrying viable endothelium through a small scleral incision. Cornea. 2002;21:415-8.

15 Price MO, Giebel AW, Fairchild KM, Price FW Jr. Descemet's membrane endothelial keratoplasty: prospective multicenter study of visual and refractive outcomes and endothelial survival. Ophthalmology. 2009;116:2361-8.

16 Kruse FE, Laaser K, Cursiefen C, Heindl LM, Schlötzer-Schrehardt U, Riss S,Bachmann BO. A stepwise approach to donor preparation and insertion increases safety and outcome of Descemet membrane endothelial keratoplasty. Cornea. 201;30:580-7.

17 Hamzaoglu EC, Straiko MD, Mayko ZM, Sáles CS, Terry MA. The First 100 Eyes of Standardized Descemet Stripping Automated Endothelial Keratoplasty versus Standardized Descemet Membrane Endothelial Keratoplasty at One Institution. Ophthalmology. 2015 Aug 11. pii: S0161-6420(15)00674-0. doi:

18 Yoeruek E, Rubino G, Bayyoud T, Bartz-Schmidt KU. Descemet membrane endothelial keratoplasty in vitrectomized eyes: clinical results. Cornea. 2015;34:1-5.

19 Siu GD, Young AL, Jhanji V. Alternatives to corneal transplantation for the management of bullous keratopathy. Curr Opin Ophthalmol. 2014;25:347-52.

20 Koizumi N, Okumura N, Ueno M, Kinoshita S.New therapeutic modality for corneal endothelial disease using Rho-associated kinase inhibitor eye drops. Cornea. 2014;33 Suppl 11:S25-31.

21 Kinoshita S. Research and development for treating devastating corneal diseases. Nihon Ganka Gakkai Zasshi. 2010;114:161-99.

22 Bahar I, Kaiserman I, Levinger I et al. Retrospective contralateral study comparing descemet stripping automated endothelial keratoplasty with penetrating keratoplasty. Cornea 2009;28: 485-8.

23 Dapena I, Ham L, Melles GR. Endothelial keratoplasty: DSEK/DSAEK or DMEK--the thinner the better? Curr Opin Ophthalmol 2009;20:299-307.