

Deep anterior lamellar keratoplasty in various indications and its comparison with penetrating keratoplasty

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Introduction

Diseases affecting the cornea are a major cause of blindness all over the world, second only to cataract in overall importance. The prevalence of corneal diseases varies from country to country and even from one population to another, depending on many factors such as the availability and general standards of eye care. In India, there are approximately 6.8 million people who have corneal blindness with vision less than 6/60 in at least one eye, and of these, about 1 million have bilateral corneal blindness^(1,2). Of all the organ transplants, corneal transplantation is unique as it is easy to harvest from the donor, can be done anywhere and does not require specialized facilities such as sterile theatre and equipment needed is minimal. Advances in ophthalmology as improved surgical techniques, operating with microscopes, improved sutures and advances in eye banking have increased.

The success rate of corneal transplants making it amongst the most successful organ transplants.

In India, nearly 3.5 million good-quality donor corneas are required to restore vision in all the eyes that can be treated with keratoplasty. However, only approximately 20,000 corneas or eyes are collected annually, while every year, approximately 40,000 new cases of corneal blindness are added to the existing backlog, creating a huge disparity between demand and supply. Thus, attempts to reduce the load of corneal blindness by corneal transplantation surgery are not optimal.

This study was done to see the visual outcome and graft failure of two different techniques (DALK, PK) of keratoplasty in clinical practice, so that we can acquire a technique with a better visual outcome and a lesser graft failure rate for selected cases. However various studies shows the below mentioned advantages and disadvantages of DALK over PK.

Advantages of DALK Over PK^(3,4,5,6)

- Extraocular procedure
- Less potential for intraocular complications such as endophthalmitis, expulsive haemorrhage, cataract and glaucoma
- Less astigmatism
- Less chances of graft rejection and consequently decreased need of topical steroids.

- Less wound dehiscence
- Donor quality criteria less stringent
- Less risk in patients who show poor compliance with medical instructions, or experience difficulty in attending frequent follow-up sessions.
- Does not preclude a future penetrating keratoplasty

Disadvantages

- Technically difficult
- Interface scarring
- Epithelial defects
- Less than optimal visual results

Materials & Methods

This is a prospective, comparative study designed to evaluate indications, risk factors and outcome of optical anterior lamellar keratoplasty and its comparison with penetrating keratoplasty. We examined 30 cases who presented in out-patient department of Upgraded Department of Ophthalmology, L.L.R.M. Medical College and associated S.V.B.P. Hospital, Meerut. During the study time of June 2009 to July 2010, with the minimum visual acuity of light perception and accurate projection of rays. We did a proper slit lamp examination, B scan & screened the patients for amblyopia, glaucoma, squint, retinal disorders, trauma etc. patients with superficial corneal scars restricted to upper 2/3rd of the corneal stroma were taken for DALK(Manual, Free Hand Dissection) and scars involving the whole thickness of cornea for penetrating keratoplasty.

Routine post-operative medication included

- Tab. Acetazolamide 250 mg orally QID
- Tab. Ibuprofen SOS
- Tab. Ciprofloxacin 500 mg BID
- Tab. Prednisolone 1 mg/Kg body weight OD
- Tab. Ranitidine 150 mg BD
- Steroid antibiotic drops 2 hrly
- Preservative free lubricants 1 hrly
- Homatropine eye drops 6 hrly (Patients with healed herpetic keratitis were given oral acyclovir 400mg twice a day for 1 year after keratoplasty).

The following follow up schedule was followed.

- Daily, till the patient was discharged
- Weekly, till one month

- Fortnightly, till three months
- Monthly, till six months
- Every two months till one year
- Six monthly, thereafter

Follow up protocol – At each follow up visit, following was assessed.

Each patient was clinically evaluated for relief of symptoms like pain, watering, redness, inability to open the eyes due to photophobia.

Visual status(UCVA , BCVA)

Graft clarity (grading suggested by RP Center for Ophthalmic Sciences, AIIMS, New Delhi).

4+ optically clear cornea, iris details clearly visible

3+ minimally hazy cornea, iris details visible

2+ hazy cornea, iris and pupillary edge visible, details not clear.

1+ very hazy cornea, iris barely visible

- Totally opaque cornea
- Graft host interface

- Epithelium, stroma, descemet’s membrane, endothelium.
- Sutures (Seidel’s test if required)
- Anterior chamber depth
- Intraocular pressure
- Any complications, if seen. (Any immediate post-op. complication like epithelial defect, suture infiltration and late complications like rejection, astigmatism were given due attention and treated).

Results

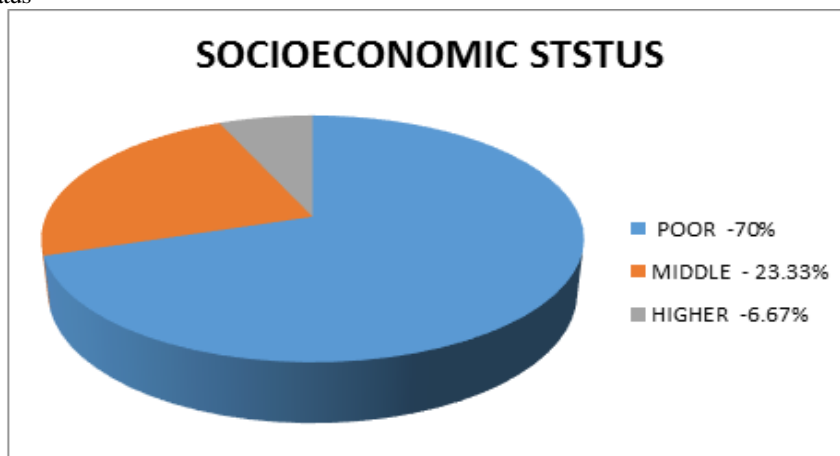
Thirty patients (30 eyes) undergoing keratoplasty were studied. Of these 15 patients underwent penetrating keratoplasty & 15 underwent deep anterior lamellar keratoplasty. It was observed that maximum number of cases 14 (46.67%) were in the age group of 41-60 years followed by 9 cases (30%) in >60 years, 5(16.67%) cases in age group of 21 -40 years and between 0-20 years only 1 case(3.33%).

Table 1: Age and Sex Distribution

| Age (Years) | Number of Cases | DALK | | Number of Cases | PK | |
|-------------|-----------------|-------|--------|-----------------|-----------|--------|
| | | Male | Female | | Male | Female |
| 0-20 | 1 | — | 1 | 1 | — | 1 |
| 21-40 | 2 | 2 | - | 3 | 2 | 1 |
| 41-60 | 7 | 4 | 3 | 7 | 5 | 2 |
| >60 | 5 | 3 | 2 | 4 | 2 | 2 |
| Total | 15 (100) | 9(60) | 6(40) | 15(100) | TC4E9(60) | 6(40) |

Among these 30 cases, 18 (60%) were male and 12(40%) were female, indicating that male persons are more exposed to outdoor work, so prone to trauma, infection and thus leading to more incidence of graft failure.

Socio-Economic Status



Our observation showed that poor socio-economic status people (70%) were more affected than the higher socio-economic status(6.67%).

Table 2: Indications of Keratoplasty

| S. No. | Indications of DALK | Number of Eyes (%age) |
|--|--|-----------------------|
| 1. | Corneal Scar | 9 (60) |
| | • healed inf. Keratitis (non-herpetic) | 5(33.33%) |
| | • herpetic scarring | 4(26.67%) |
| 2. | Surface Corneal Dystrophy | 4 (26.67%) |
| 3. | Surface Corneal Degeneration | 2 (13.33) |
| | Total | 15 (100) |
| Indications of Penetrating Keratoplasty | | |
| 1. | Vascularized corneal scars | 7(46.67%) |
| | • Healed infectious keratitis (non-herpetic) | 4(26.67%) |
| | • Herpetic Scarring | 2(13.33%) |
| | • Trauma | 1(6.67%) |
| 2. | Band shaped keratopathy | 01(16.67%) |
| 3. | Aphakic Bullous Keratopathy | 02(13.33%) |
| 4. | Pseudophakic Bullous Keratopathy | 03(20%) |
| 5. | Corneal Dystrophy | 02(13.33%) |
| | Total | 15(100) |

It was observed that corneal scar (9 of 15 eyes; 60%) was the most common primary indication for corneal grafting in DALK group, followed by surface corneal dystrophy (4 of 15 eyes; 26.67%) & surface corneal degeneration (2 of 15 eyes; 13.33%). The most common cause of vascularized corneal scars was healed microbial keratitis (non-herpetic; 33.33, followed by herpetic keratitis (26.67%) cases.

In PK group, vascularized corneal scar (7 of 15 eyes; 46, 67%) was the most common primary indication for corneal grafting, microbial keratitis (non-herpetic; 26.67%), followed by pseudophakic bullous keratopathy (3 out of 15eyes, 20%) followed by herpetic keratitis (13.33%) and trauma (6.67%) cases.

Table 3: Complications Encountered Post Operatively

| Complications | Number of Eyes(DALK) | Percentage | Number of Eyes(PK) | Percentage |
|---|----------------------|------------|--------------------|------------|
| Interface Scarring | 3 | 20 | - | - |
| Astigmatism | 3 | 20 | 7 | 46.67 |
| Recurrence of Host Pathology | 2 | 13.33 | | |
| Delayed Epithelialisation/ Epithelial Defect | 2 | 13.33 | 2 | 13.33 |
| Vascularisation | 1 | 6.67 | - | - |
| Secondary Infection/ Corneal Ulcer/ Perforation | 0 | 0 | 2 | 13.33 |
| Graft Rejection | - | - | 2 | 13.33 |
| Bullous Keratopathy | - | - | 01 | 6.67 |
| Glaucoma | - | - | 1 | 6.67 |
| Cataract | - | - | 1 | 6.67 |
| Vitreous Hemorrhage | - | - | - | - |
| Choroidal Detachment | - | - | - | - |
| Retinal Detachment | - | - | - | - |

The most common complications encountered in DALK group was graft-host interface scarring(20%), astigmatism (20%, which is 46.67% in case of PK group), followed by delayed epithelialisation/ persistent epithelial defect (13.33%), recurrence of host pathology (13.33%), epithelial defects(13.33%), Secondary infection (13.33%), glaucoma (6.67%), cataract (6.67%).

Most common complication in PK group was astigmatism (46%), followed by graft rejection

Table 4: Average Post-Operative Visual Acuity Over 1 Year Period

| Post-Op Visual Acuity | DALK | | PK | |
|-----------------------|--------------------|-------|--------------------|-------|
| | Number of Patients | % age | Number of Patients | % age |
| >6/12 | 3 | 20 | 4 | 26.67 |
| 6/36 – 6/18 | 5 | 33.33 | 6 | 40 |
| <6/60 | 7 | 46.67 | 5 | 33.33 |
| Total | 15 | 100 | 15 | 100 |

The visual outcome in majority of patients in DALK group was <6/60 (46.67% patients) followed by 6/18-6/36 (33.33% patients) and >6/12 (20% patients), in PK group majority of the patient gain 6/18-6/36(40%) followed by <6/60(33.33%), >6/12 in 26.67% of cases.

The visual outcome in majority of PK patients was 6/36-6/18(40% patients) followed by <6/60 (33.33% patients) and >6/12 (26.67% patients). Therefore, moderate grade visual acuity was seen in most of our patients.

Table 5: Graft clarity at different follow up Times

| Follow Up Time | Graft Clarity (DALK) | | | | Graft Clarity(PK) | | | |
|----------------|----------------------|----------|----------|----------|-------------------|----------|----------|----------|
| | 1+ (%) | 2+ (%) | 3+ (%) | 4+ (%) | 1+ (%) | 2+ (%) | 3+ (%) | 4+ (%) |
| Day 1 | 2(13.33) | 4(26.67) | 3(20) | 6(40) | 1(6.67) | 3(20) | 4(26.67) | 7(46.67) |
| Day 7 | 1(6.67) | 5(33.33) | 3(20) | 6(40) | 1(6.67) | 3(20) | 4(26.67) | 7(46.67) |
| Day 15 | 1(6.67) | 3(20) | 4(26.67) | 7(46.67) | 1(6.67) | 3(20) | 5(33.33) | 6(40) |
| 1 Month | 1(6.67) | 3(20) | 5(33.33) | 6(40) | 1(6.67) | 3(20) | 5(33.33) | 6(40) |
| 3 Months | 2(13.33) | 3(20) | 5(33.33) | 5(33.33) | 2(13.33) | 3(20) | 5(33.33) | 6(40) |
| 6 Months | 3(20) | 2(13.33) | 5(33.33) | 5(33.33) | 2(13.33) | 2(13.33) | 5(33.33) | 6(40) |
| 1 Year | 3 (20) | 2(13.33) | 5(33.33) | 5(33.33) | 2 (13.33) | 2(13.33) | 5(33.33) | 6(40) |

The graft remained clear in 66.67% cases of DALK & 73.33% cases of PK.

Table 6: Causes of Graft Failure

| Cause | DALK(%) | PK(%) |
|----------------------------------|-----------|-----------|
| Immune graft rejection | 0 | 01(6.67) |
| Recurrence of Host pathology | 02(13.33) | - |
| Pseudophakic Bullous Keratopathy | - | 01(6.67) |
| Secondary infection | - | 02(13.33) |
| Interface scarring | 03(20) | - |
| Total | 05(33.33) | 04(26.67) |

Of the total 30 patients, 9 patients underwent graft failure, of which 5 were of DALK group and 4 were of PK group.

In DALK group interface scarring in 20% of cases & recurrence of host pathology (13.33%) resulted in graft failure.

In our study graft rejection(6.67%), secondary infection(13.33%) & occurrence of bullous keratopathy(6.67%) in graft resulted in graft failure in PK group.

Discussion

Corneal blindness is a significant public health problem in India. Though preventive strategies may reduce future corneal blindness, the only hope of visual recovery for those currently blind due to corneal diseases may be corneal grafting. The proportion of corneal blind who could derive long-term benefit from corneal grafting depends on the survival rate of the grafts. Corneal Transplantation has had success unequalled by other organ or tissue transplants. The primary reasons for this are the cornea's unique structure and location. In addition, the use of modern surgical techniques, improved donor storage, better

suture materials, viscoelastic substances and the use of both topical and systemic immunosuppressive drugs have all added to this success rate. Better evaluation of the donor material and the increasing skill of the surgeons have added to better results of corneal grafting. Nevertheless, corneal graft rejection continues to occur, necessitating its replacement if the desired visual outcome is to be achieved.

Indications for penetrating keratoplasty have changed drastically over the last 25 years or so. As per Smith et al and Lindquist et al (in mid twentieth century) in developed countries, the most common indications for corneal grafting were scars following herpes simplex keratitis, regrafts and keratoconus. Transplants for pseudophakic and aphakic bullous keratopathy were almost non-existent.^(7,8) In late 1980s, the main indications for transplants were regrafts and keratoconus with ABK becoming a fairly common indication.

Buxton et al and Robin et al in their study indicated that PBK/ABK were the leading indications.^(9,10)

In a study by Randleman JB et al performed at both country hospital and Veterans Affairs facilities, indications for P.K. included failed graft (29.1%), bullous keratopathy (21.5%), keratoconus (20.3%), corneal scar (19.0%), corneal perforation from infection (6.3%), and Fuch's endothelial dystrophy (3.8%).⁽¹¹⁾

According to D T H Tan et al⁽¹²⁾ study, the common indications for surgery were corneal scars (36.4%), keratoconus (28.6%) and corneal dystrophies (13.6%).

In our study, it was observed that corneal scar (60% in DALK & 46.67% in PK group) was the most common primary indication for corneal grafting, the

most common cause of vascularized corneal scars was healed microbial keratitis (non-herpetic; 33.33% in DALK & 26.67% in PK group), followed by herpetic keratitis (26.67% in DALK & 13.33% in PK group).

The majority of patients had pre-operative visual acuity of FCCF-6/60 (11 patients equivalent to 73.33% of total) followed by those with visual acuity <FCCF (3 patients equivalent to 20%) and visual acuity >6/60 (1 patient equivalent to 6.67% of total) in DALK group.

The majority of patients had pre-operative visual acuity of <FCCF (8 patients equivalent to 53.33% of total) followed by those with visual acuity FCCF-6/60 (3 patients equivalent to 33.33%) and visual acuity >6/60 (2 patient equivalent to 13.33% of total) in PK group.

Anshu et al⁽¹²⁾ did a study showing complications of corneal grafting, according to it Complications following PK were glaucoma (15%), endothelial rejection (12%) and epithelial problems (11%); in the lamellar group, glaucoma (9%), epithelial problems (5%) and Descemet's detachment (3%) were more common.

In our study, the common complications(in DALK) encountered were graft-host interface scarring (20%), delayed epithelialisation/ persistent epithelial defect (13.33%), recurrence of host pathology(20%) and folds in Descemet's membrane(13.33%). Thus, we can correlate from our study that interface scarring and recurrence of host pathology affected the visual outcome maximally in DALK. The high percentage of complications as reflected above are also due to the less number of patients who underwent the procedure during our study period.

Common complications following PK were graft rejection (13.33%), epithelial defects (13.33%), secondary infection (6.67%), bullous keratopathy (6.67%), astigmatism (46.67%), glaucoma (6.67%), cataract (6.67%).

Secondary infection was seen in only 2 patient of PK group, of which 1 was following suture removal. It was not seen in DALK group.

The epithelium problems were similar in both the group (13.33%).

The postoperative astigmatism of > 5 D was seen in 50% of patients of PK group & 4% of patients of DALK group after 6 month in a study by Anita Panda et al.⁽¹³⁾

In our study astigmatism of > 5 D was seen in 40% of cases of PK group and 6.67% of cases of DALK group.(<3 D seen in 6.67 % of PK & 13.33% of DALK group.)

Interface scarring in DALK & astigmatism in PK were major limiting factors in terms of visual outcome in our study.

Secondary glaucoma was also seen in the 1 patient of transplant group (PK, 6.67%), and was medically controlled, which is less than that seen in previous studies(15%).⁽¹³⁾

The integrity of the corneal epithelium after lamellar keratoplasty is a very important factor in wound healing and graft clarity. Various factors belonging to the donor and host as well as the surgical

procedure may affect the viability and integrity of the donor epithelium. Average time for complete epithelialization of a corneal graft is 4-6 days. A persistent epithelial defect can give rise to graft ulceration, stromal melting, and perforation and even graft failure. In our study important factors leading to epithelial defects have been identified as tight sutures, tear film abnormalities and dry eye, herpetic keratitis, stem cell deficiency, and use of epitheliotoxic drugs like fluoroquinolones, timolol maleate, and prednisolone acetate eye drops. Besides that, few cases with evidence of good healing in the early postoperative period, reported this complication later in their course of follow up. It was found that a wrong method of instillation of drugs can also lead to epithelial defects.

The visual outcome in majority of patients in our study was <6/60(46.67% patients) followed by 6/36-6/18 (33.33% patients) and >6/12 (20% patients) in DALK.

The visual outcome in majority of PK patients was 6/36-6/18(40% patients) followed by <6/60 (33.33% patients) and >6/12 (26.67% patients). Therefore, moderate grade visual acuity was seen in most of our patients in PK.

On last follow up observed at the end of 1 year,5 patients i.e. 33.33% patients had 4+ graft clarity, 5 patients i.e.33.33% patients had 3+ clarity, 2 patients i.e. 13.33% had 2+ graft clarity and 3 patients i.e. 20% patients had 1+ graft clarity in DALK group.

At the end of 1 year in PK group,6 patients i.e. 40% patients had 4+ graft clarity, 5 patients i.e.33.33% patients had 3+ clarity, 2 patients i.e. 13.33% had 2+ graft clarity and 2 patients i.e. 13.33% patients had 1+ graft clarity in PK group.

Attainment of BCVA in DALK group is slightly later than that achieved in PK group, but there is no significant difference in finally attained visual acuity (the BCVA is slightly lower in DALK group as compared to that achieved in PK group).

These results are similar to the results of previous studies by Arashv and et al⁽¹⁴⁾ and Carlos et al.⁽¹⁵⁾

DALK is technically more challenging & conventional manual forms of DALK are usually associated with poorer visual outcome as compared with PK owing to the fact that it is usually not possible to consistently perform complete lamellar dissection down to the DM, and retention of posterior stromal layer, which may still have scarring, can also lead to interface haze and bed irregularity from manual attempts at stromal dissection, however with the advent of descemetric DALK procedures, such as big bubble technique, this limitation can be overcome.

DALK is essentially an extraocular procedure and avoidance of surgical entry into the anterior chamber reduces the risk of introducing infectious organisms into the AC at the time of surgery, thereby reduces the risk of secondary endophthalmitis. In our series none of the patient in DALK group showed secondary infection,

as compare to 2(13.33%) eye of PK group. there is also lower incidence of cataract & glaucoma in DALK group, possibly due to its extraocular approach or less prolonged use of topical steroid in lamellar grafts. In our study 1 eye(6.67%) of PK patient developed raised IOP postoperatively, which was controlled medically ,none of DALK group developed raised IOP postoperatively.

Another major advantage of DALK surgery is the preservation of relatively unaffected recipient endothelium, which greatly reduces the risk of allograft rejection and subsequent late endothelial failure. In our study none of the patient in the DALK group developed allograft rejection compared with 2 eyes (13.33%) in the PK group, of which one eye eventually developed graft failure.

Previous studies (Dandona et al)⁽¹⁶⁾ had reported graft rejection as a cause of 29.2% & infection in 15.4% cases of graft failure. In our study graft rejection is responsible for 6.67% of graft failure & secondary infection in 13.33% of graft failure in PK group.

In DALK group 13.33% of failed graft were due to recurrence of host pathology and 20% were due to interface scarring.

Previous studies (Awan et al)⁽¹⁷⁾ had reported the recurrence of HSV related inflammation in 33% of DALK cases.in our study the recurrence is less as the patients with history of herpetic infection were prophylactically treated with 400 mg of oral acyclovir twice daily. The reported recurrence of herpes infection in prophylactically treated group is 14% in previous studies, similar to our study.⁽¹⁸⁾

Conclusion

Our study reports successful outcomes of DALK in patients with varied etiologies, as compared with penetrating keratoplasty, in terms of graft survival and visual outcome.

The high percentage of some complications as reflected above are due to the less number of patients who underwent the procedure during our study period.

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