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## Deep anterior lamellar keratoplasty in keratoconus

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**Abstract**---Aims: To analyse the outcome of DALK in patients with keratoconus in terms of best corrected and uncorrected visual acuity, average K and topographic astigmatism. Settings and design: Prospective interventional case series study Material and methods: 28 eyes of 28 patients diagnosed with keratoconus were evaluated from August 2009 – July 2011 in a tertiary eye care hospital. All patients underwent DALK and outcomes were assessed on 4 parameters: Average Keratometric reading, topographic astigmatism, UCVA and BCVA alongwith epidemiological analysis. Statistical analysis used: ANOVA testing and Dunnett multiple comparison test. Results: We had evaluated 28 eyes of 28 patients (10 males and 18 females) in the age group of 15 to 35 years. Cases were classified as moderate (4) and severe (24) category. There was a statistical significant decrease Average K and Topographic Astigmatism in post op period which was evaluated at 1, 3 and 6 months. (p value <0.05). From the sample size, all of the patients showed improvement in visual acuity by more than one Snellens. No significant post operative complications occurred. Conclusion: DALK is a safe and effective treatment for severe keratoconus, corneal scarring and contact lens intolerance. The visual acuity gained was statistically significant (gain in Snellens by mean of 5.42 lines). There is a decrease in astigmatism by 4.17D.

**Keywords**---DALK, Average Keratometry, keratoconus, Topography, astigmatism, BCVA.

## Introduction

Keratoconus (KC) is a progressive, noninflammatory, bilateral (but usually asymmetric) ectatic corneal disease, characterized by paraxial stromal thinning and weakening that leads to corneal surface distortion. Visual loss occurs primarily from irregular astigmatism and myopia, and secondarily from corneal scarring. Keratoconus causes a significant psychosocial disability as it the disease of the young wherein it disrupts the day to day functioning especially in severe cases thus affecting quality of life. Management of keratoconus is often complex and differs at different stages and state of progression of the disease.

In mild to moderate cases patients are prescribed spectacles or contact lens. If there is evidence of progression of the disease then collagen cross linking can be opted. Rabinowitz et al have shown that there is no sex preference or no known geographic pattern. Keratoconus has its onset at puberty and progresses until 3<sup>rd</sup> to 4<sup>th</sup> decade. Its incidence in general population is reported to be 2300 in 100,000 in India.<sup>[1]</sup> Epikeratoplasty and Thermokeratoplasty were methods used before the age of Penetrating Keratoplasty (PK). PK is a full-thickness transplant procedure, in which a trephine of an appropriate diameter is used to make a full-thickness resection of the patient's cornea, followed by placement of a full-thickness donor corneal graft was initially the procedure of choice for corneal ectatatic conditions.<sup>[2]</sup>

Later with emergence of deep anterior lamellar keratoplasty (DALK), it had become the treatment of choice replacing penetrating keratoplasty in cases of advanced keratoconus. This is a technique in which cornea is dissected up to the descemet's membrane using big bubble technique, air/saline assisted dissection as in Melles technique and a donor tissue is sutured in place. The main advantages are that it is an extraocular procedure, and it preserves the host's descemet's membrane and endothelium, reducing chances of tissue rejection and complication, providing early visual rehabilitation. Advantages offered over PK was reduced chances of graft rejection as intact endothelium was left, but studies showed that increased astigmatism was present when compared to PK <sup>[3]</sup>. A study done by Almamoun Abdelkar et al with pre – descemet DALK where 75% stroma is removed leaving a thin layer of stroma, showed that keratocyte reflectivity and morphology returned to normal in 4 – 6 weeks, suggesting that depth of lamellar bed, smoothness and healing process at interface are keys to optimal visual acuity<sup>[4]</sup>. Newer techniques such as Bowman layer transplantation where partial restoration of corneal anatomy might be obtained through a mid – stromal implant of an isolated Bowman's layer graft to flatten the corneal curvature for cases with extreme thinning and steepening <sup>[5]</sup>, Femto second assisted laser and diamond burr are also under evolution, visual outcomes are similar but provides safe and effective dissection especially in scarred corneas. <sup>[6]</sup>

Intra operative OCT (iOCT) provides critical information to the surgeon on relative depth, tissue planes and optimal tissue localization thus preventing intra operative complication. PIONEER study by John Au et al on 18 eyes showed that iOCT helped in providing images during each step of the surgery, aiding in better outcomes.<sup>[7]</sup> In our study, an effort has been made to study the outcome in terms of visual acuity and topographic astigmatism improvement in patients undergoing

deep anterior lamellar keratoplasty with the conventional big bubble technique. Patients were followed upto 6 months.

### **Materials and Methods**

- Study design:  
Prospective interventional case series study
- Duration and place of study:  
August 2009 to July 2011 at Sankara Eye Centre, Coimbatore

Moderate and severe keratoconus, average keratometric reading >60 D and Intolerance to Rose K2 contact lens or rigid contact lens were included. Early or Mild Keratoconus and central corneal scarring due to post hydrops were excluded.

### **Diagnostic Technique**

Patients were diagnosed based on history, slit lamp biomicroscopic examination and ophthalmic investigations. Patients gave a history of frequent change of glasses, contact lens intolerance (rigid or rose K2), Vision not improving with glasses on subjective refraction. On slit lamp examination patients showed thinning of cornea with signs like Vogt's striae, Fleischer ring, Munson sign, deep anterior chamber, prominent corneal nerves or scarring. After that patient underwent topographic examination (Optikon scout, Italy) and definite diagnosis was established. The CLMI (cone location and magnitude index) a software built in Keratocon Topographer helped in locating the center of the cone and its magnitude. Patients with CLMI <20% PPK (predictive progression of keratoconus) were categorized normal, 20-45% were suspects, >45% were definite keratoconus. The central corneal power, the corneal apex, and the simulated keratometry values in the two major axes will be noted from the selected axial map and instantaneous maps. The average of simulated keratometry [axial] values (average Sim K) was used to categorize keratoconus eyes into severity grades of:

- Mild (average Sim K < 51D)
- Moderate (average Sim K 51-60D)
- Severe (average K > 60D).

All patients with moderate - severe keratoconus, central corneal scarring, pachymetry values unsuitable for CXL or whose visual acuity was assessed would not improve with CXL underwent DALK.

### **Operative technique**

After abiding by criteria of Declaration Of Helsinki and approval from ethical committee, informed and written consent was obtained from each patient. The surgeries were performed in a sterile OT room under general anaesthesia. A single surgeon performed all surgeries using Anwar's Big Bubble Technique to do DALK. A pupil centered partial thickness corneal trephination of 7.5 to 8.5mm was done. A sterile 30 G needle mounted on 1cc syringe, air was introduced in deep corneal stroma creating a cleavage plane between stroma and descemet's membrane. Paracentesis was made with a 15 degree knife to reduce intraocular pressure by

releasing air that might have entered the anterior chamber. Initial groove is deepened and stroma dissected with a mini crescent knife taking care not to perforate descemet's membrane. The air bubble is pierced and entire stroma is separated from recipient's bed. No debris were left behind to prevent any interface opacities post operatively. The descemet's membrane was peeled off from the donor button. Same sized donor button was placed. 2/3<sup>rd</sup> thickness interrupted, continuous, double continuous or interrupted with continuous sutures were taken. Bandage contact lens was placed at the end of the surgery with protective eye gear and removed after 3 days. Post operative regimen: chloramphenicol 0.5% + dexamethasone sodium phosphate 0.1% (Dexoren – S, Indico excel) which was tapered over 3 months. Lubricating drops (Refresh Tears, Allergan) were used for 1 month. The sutures were removed at 3 months if they caused astigmatism post operatively as seen on corneal topography. Patients were followed up on 1, 3 and 6 monthly intervals and evaluated for UCVA and BCVA with Snellen's chart, Average K and Topographic astigmatism. At end statistical data was collected and analysed.

### **Results and Statistical Analysis**

We had evaluated 28 eyes (10 males and 18 females) of 28 patients in the age group of 15 to 35 years. Patients were divided into 3 groups age-wise with 16 patients (57.14%) in 15 to 22 years, 10 patients (35.71%) in 23 to 29 years and 2 patients (7.14%) in 30 to 35 years respectively. Cases were classified as moderate and severe with 4 (14.28%) and 24 (85.71%) patients in each category respectively.

**Average keratometry:** The mean values and standard deviation of K average pre - op, 1 month, 3 months, and 6 months are 57.24D, 44.12D, 43.89D, 43.53D and 4.79D, with standard deviation of 3.11D, 3.04D and 2.68D respectively. Hence there was a reduction by 13.12D, 13.35D, 13.7D at 1, 3, 6 months respectively. This shows that in severe keratconus there was a significant decrease in average K reading leading to the normalisation of the corneal curvature. ( $p < 0.01$  at 1, 3 and 6 months compared to before treatment)

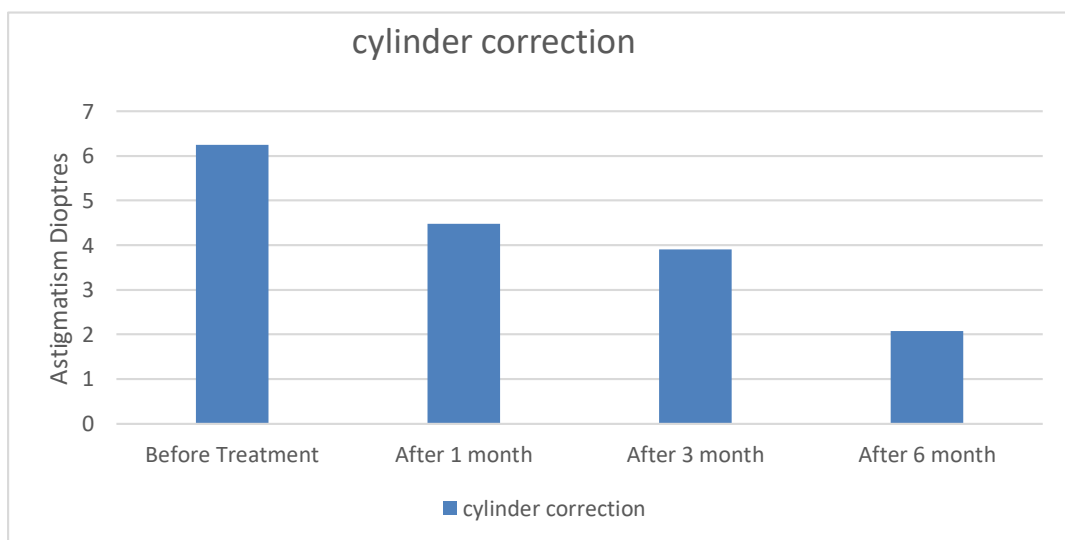
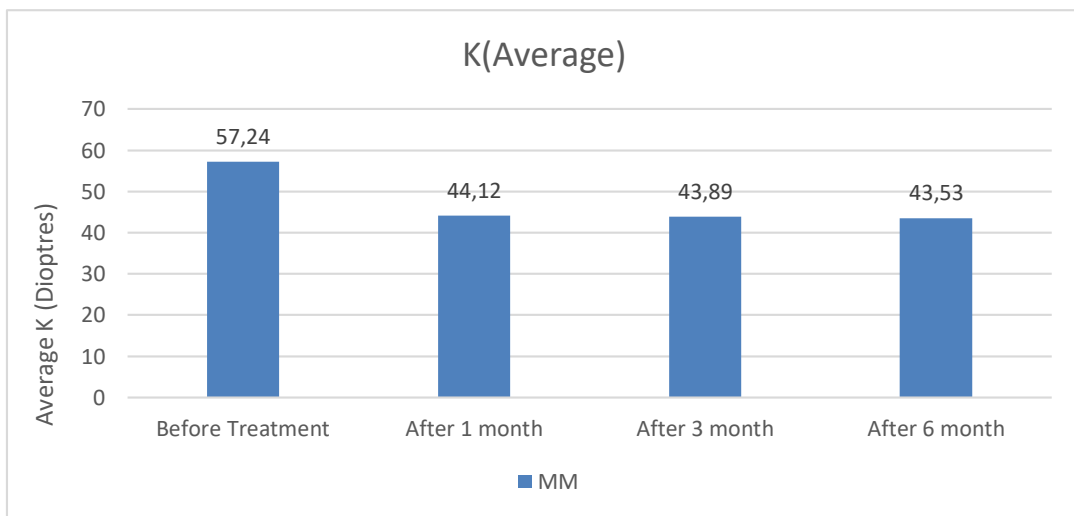
**Topographic Astigmatism:** There was a significant decrease in astigmatism. Pre-operative, 1 month, 3 months, 6 months mean values are 6.25D, 4.48D, 3.91D and 2.08D and standard deviation was 2.35D, 1.72D, 2.05D and 0.76D respectively. There was a decrease in astigmatism by 1.77D, 2.34D and 4.17D at 1, 3, 6 months post operatively. This was statistically significant as  $p < 0.01$  at 1, 3 and 6 months.

**UCVA (Uncorrected visual acuity):** 24 patients showed improvement while 4 patients had stabilization in visual acuity. There was 1,3,7,8,9 lines of improvement in 3 eyes each; 3 and 6 lines improvement in 4 eyes each and 4 line improvement in 1 eye. There was a mean improvement of 4.66 line in Snellen's visual acuity chart.

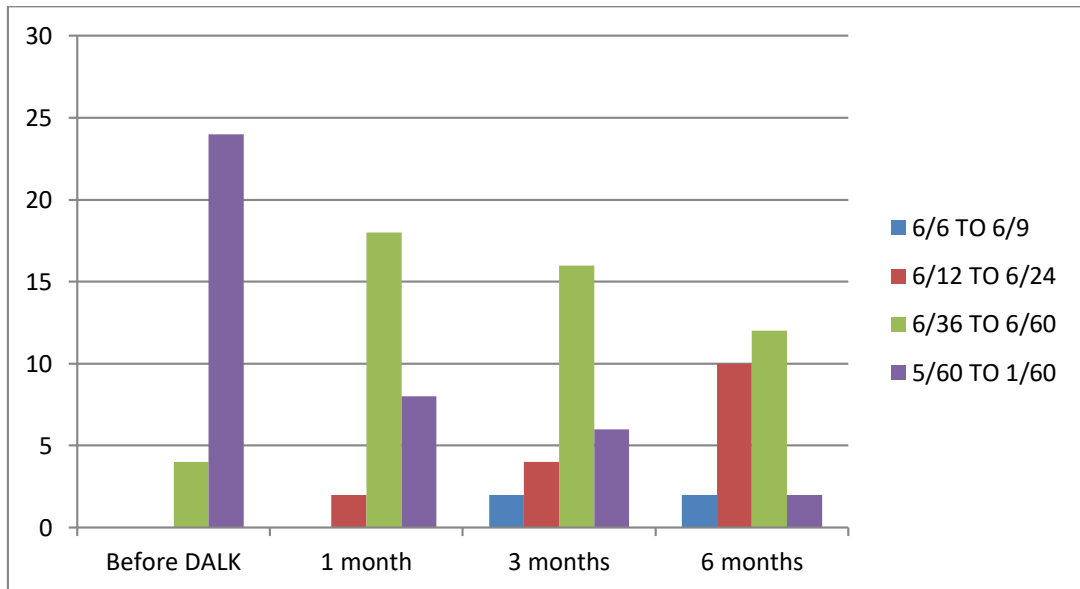
**BCVA (Best corrected visual acuity):** Out of 28 eyes, all had improvement in visual acuity by more than 1 line in Snellen's visual acuity chart. There was 3,4,6,9 lines

of improvement in 6 eyes each and 5 line improvement in 4 patients. There was a mean improvement of 5.42 line in Snellen's chart.

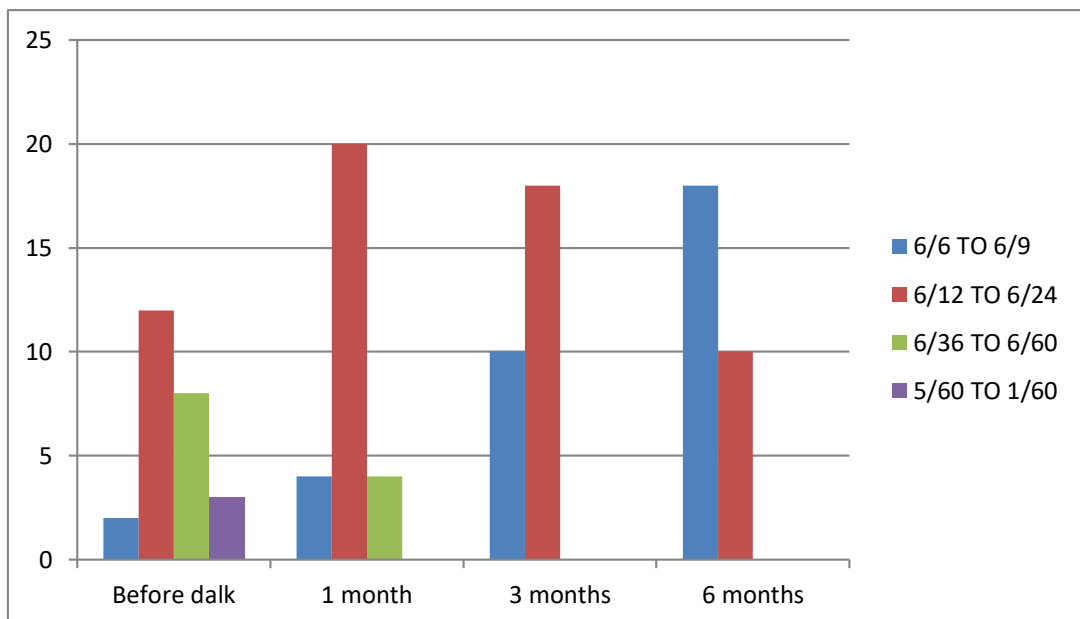
Statistical tests used: Average Keratometry and Topographic Astigmatism was assessed using one way ANOVA for paired results and Dunnett multiple comparison tests for comparing post treatment results with pretreatment values. Analytical Results: p value  $<0.05$  was considered statistically significant according to ANOVA tests.  $p < 0.0001$  was obtained for average keratometry and cylinder correction which was extremely significant (in this case decrease) in values after DALK. We compared each follow up visit (1, 3 and 6 months after surgery) with Dunnett multiple comparison tests which gave a p value of  $<0.01$ , which was equally significant.



## UCVA



## BCVA

**Discussion**

Management of keratoconus is often complex and differs at different stages and state of progression of the disease. Special attention should be given to optimize visual outcome depending on the need of the patient. The various modalities available today can be broadly divided into nonsurgical and surgical. Our study

was focused on the surgical management of severe keratoconus not improving with the spectacles or contact lens. This study was done in 2009 to 2011 when DALK was done with big bubble technique which was very popular back then. We reviewed 28 patients over a period of one and half year and followed up for 6 months.

**Average keratometry:** In our study, there was a decrease in Average K of 13.7 D at the end of 6 months which is extremely significant statistically with a p value of <0.05. In a study by Fontana et al<sup>[8]</sup> showed that average keratometry decreased by 14.59 D after surgery. Another study on DALK done by J K Reddy<sup>[9]</sup> in 53 patients showed a reduction of 9.1D in mean post op keratometry reading. **Topographic astigmatism:** There was a decrease in astigmatism by 4.17D at end of 6 months which is statistically significant as p<0.01. In a study done by Kubaloglu<sup>[10]</sup> A about comparison of PKP and DALK, the mean refractive cylinder was decreased  $2.74 \pm 1.44$  D in the DALK group. In another study by Richard J<sup>[11]</sup> they showed that astigmatism decreased by 1.75D.

### **UCVA and BCVA**

Out of the 28 patients treated for DALK, 24 patients showed improvement while 4 patients had stabilization in UCVA with a mean improvement of 4.66 line in Snellen's visual acuity chart. While in BCVA all had improvement in visual acuity by more than 1 line in Snellen's visual acuity chart with a mean improvement of 5.42 line in Snellen's chart. In a study by Kubaloglu A<sup>[12]</sup>, UCVA was lower than 20/100 in all eyes preoperatively and better than 20/100 in 191 eyes (81.6%) postoperatively. BCVA was 20/40 or better in 187 eyes (79.9%) and 20/20 or better in 38 eyes (16.2%). Also studies done by Bahar et al, Fogla et al, Fontana et al<sup>[8,13,14]</sup> all the patients had a visual acuity better than 6/12 post operatively. Study done by Al-Torbak et al<sup>[15]</sup> 75% of patients had visual acuity better than 6/12.

### **Complications**

There were no intra operative complication. None of the surgeries were converted into PK. One patient had mild peripheral interface wrinkling post operatively which did not affect the visual outcome of the patient.

**Financial Disclosures:** None

**Conflicts of interest:** None

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