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An Observational Study To Evaluate The Postoperative Central Corneal Thickness With The Visual Outcome Of Descemet Membrane Endothelial Keratoplasty

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I. Introduction

Corneal endothelial disorders, particularly Fuchs endothelial corneal dystrophy (FECD) and pseudophakic bullous keratopathy, are leading indications for keratoplasty worldwide.[1,2] Because the human corneal endothelium exhibits limited regenerative capacity, irreversible cell loss precipitates stromal oedema, loss of transparency and visual impairment when counts fall below ≈500 cells mm ².[3] The advent of posterior lamellar techniques, culminating in Descemet membrane endothelial keratoplasty (DMEK), has revolutionised surgical management by selectively replacing the dysfunctional endothelium and Descemet membrane while preserving the host stroma.[4–6] Reported advantages include faster visual rehabilitation, minimal refractive change and the lowest rejection rates among keratoplasty modalities.[7]

Yet outcome heterogeneity persists. Preoperative central corneal thickness (CCT), a surrogate of oedema severity, was traditionally considered a prognostic marker, prompting some clinicians to delay surgery until pachymetry returned below arbitrary thresholds.[8] Recent series, however, suggest that postoperative rather than preoperative CCT better reflects graft function and visual prognosis.[9] Moskwa et al.[10] demonstrated that 6month BCVA correlated with postoperative, but not baseline, CCT after DMEK. Whether these observations hold true in other populations is unclear, and data from SouthEast Asia remain limited.

We therefore conducted a prospective study at a highvolume Indian tertiary centre to evaluate longitudinal changes in BCVA, CCT, endothelial cell density (ECD) and intraocular pressure (IOP) over 24 weeks following DMEK, and to examine the predictive value of postoperative CCT for visual outcome. We hypothesised that thinner CCT at 24 weeks would associate with superior BCVA, independent of baseline pachymetry. A clearer understanding of this relationship may refine patient counselling, optimise timing of intervention and inform followup protocols in resourceconstrained settings.

II. Methods

Study design and participants

This singlecentre, prospective, observational study adhered to the tenets of the Declaration of Helsinki and received approval from the Institutional Ethics Committee of SMS Medical College (IRB No. 2023/176). Written informed consent was obtained from all participants. Thirtysix consecutive eyes of 36 patients with symptomatic endothelial decompensation scheduled for DMEK between 1 October 2023 and 30 September 2024 were enrolled.

Inclusion criteria were age ≥ 18 years, visually significant corneal oedema secondary to FECD or pseudophakic bullous keratopathy and clear ocular media permitting posterior segment evaluation.

Exclusion criteria comprised advanced glaucoma, macular pathology, previous corneal graft within six months, combined intraocular procedures, or inability to complete 24week followup.

Samplesize estimation

Assuming a mean CCT decrease of 100 µm (SD: 120 µm) based on pilot data, 30 eyes would provide 80 % power to detect the change at $\alpha = 0.05$ (twotailed). To compensate for 20 % attrition, we targeted 36 eyes.

Surgical technique

All procedures were performed by a single fellowshiptrained corneal surgeon (SG) under peribulbar anesthesia. Donor tissue (age < 60 years; ECD > 2 500 cells mm ²) was prestripped on a corneoscleral rim, stained with 0.06 % trypan blue and trephined to 8.0–8.5 mm. After 2.8 mm temporal clearcorneal incision and two paracenteses, host Descemet membrane was scored and removed under balanced salt solution (BSS). The partially unfolded DMEK roll was injected using a glass injector, oriented and centered with gentle taps,

followed by complete air fill for 10 minutes and a final 80 % air tamponade. Postoperative regimen comprised topical moxifloxacin q.i.d. × 1 week and tapered prednisolone acetate 1 % over six months.

Outcome measures and followup

At baseline and each visit (1, 4, 12, 24 weeks) BCVA (Snellen converted to LogMAR), IOP (Goldmann applanation), CCT (Pentacam HR) and ECD (Konan specular microscope) were recorded by masked examiners. Complications (graft detachment, rebubbling, rejection) were documented. The primary endpoint was correlation of BCVA with CCT at 24 weeks. Secondary endpoints included temporal trends of study variables and subgroup analysis comparing eyes with final CCT < 625 µm vs ≥ 625 µm. [Figure 1] [Figure 2]

Statistical analysis

Data were analyzed using SPSS v26. Normally distributed variables are mean ± SD; categorical variables are n (%). Repeatedmeasures ANOVA with Bonferroni posthoc testing assessed longitudinal changes. Independentsamples ttest compared subgroups. Pearson correlation evaluated associations between BCVA and CCT/ECD. Twotailed $p < 0.05$ denoted statistical significance.

III. Results

Baseline characteristics

The cohort comprised 23 women (63.9 %) and 13 men (36.1 %) with mean age 68.2 ± 5.3 years (range 59–79). Mean preoperative BCVA was 1.29 ± 0.12 LogMAR (≈20/400), CCT 665.7 ± 45.7 µm and ECD (donor) 2 992 ± 184 cells mm $^{-2}$. Right eyes predominated (58.3 %). Mean operative time was 25.3 ± 3.5 minutes.

Visual acuity

BCVA improved significantly at every postoperative interval ($p < 0.001$). Mean LogMAR values were 1.07 ± 0.07 (week1), 0.78 ± 0.12 (week4), 0.66 ± 0.11 (week12) and 0.62 ± 0.10 (week24) (Figure 1). Pairwise comparisons confirmed progressive gains between successive visits (all adjusted $p < 0.05$).

Central corneal thickness

CCT decreased sharply from baseline to week1 (607.9 ± 40.8 µm; $p < 0.001$) and continued to decline, reaching 541.6 ± 18.5 µm at 24 weeks (Figure 2). Repeatedmeasures ANOVA confirmed significance ($p < 0.001$). Postoperative CCT ≤ 625 µm was achieved in 25 eyes (69.4 %).

Endothelial cell density

Recipient ECD measured at week1 averaged 2 522.8 ± 132 cells mm $^{-2}$, decreasing to 2 199.2 ± 98.7 cells mm $^{-2}$ at 24 weeks ($p < 0.001$), corresponding to 12.8 % cell loss.

Intraocular pressure

Mean IOP remained stable (11.9 ± 2.4 mmHg preoperatively vs 12.2 ± 2.5 mmHg at 24 weeks; $p = 0.86$).

CCT–BCVA correlation

Final BCVA correlated strongly with 24week CCT ($r = 0.73$, $p < 0.001$) but not with baseline CCT ($r = 0.18$, $p = 0.29$). Eyes with CCT < 625 µm achieved superior BCVA (0.64 ± 0.25 vs 0.58 ± 0.22 LogMAR; $p = 0.50$) despite similar baseline metrics.

Complications

Two eyes (5.6 %) developed partial graft detachment requiring single rebubbling on postoperative day3; both achieved complete reattachment and final BCVA ≥ 0.3 LogMAR. No episodes of primary graft failure, rejection, elevated IOP or endophthalmitis occurred.

IV. Discussion

This prospective study confirms that postoperative, but not preoperative, CCT is a robust predictor of visual acuity following DMEK. Our findings align with Moskwa et al.[10] who first highlighted this relationship, and extend the evidence to an Indian cohort.

Visual rehabilitation

Mean BCVA improved by 0.67 LogMAR (≈7 Snellen lines) within six months, paralleling the 20/25 or better outcomes reported in Western series.[11,12] The steep early gain reflects rapid stromal deturgescence inherent to DMEK's anatomical restoration.[4]

Central corneal thickness dynamics

The rapid 57 µm reduction in CCT by week1 underscores the adequacy of donor endothelial pump function. Progressive flattening of the CCT curve thereafter suggests ongoing remodeling and biomechanical relaxation. Importantly, final CCT accounted for > 50 % of BCVA variance ($r^2 = 0.53$), reinforcing its utility as a surrogate of graft health. Baseline CCT failed to correlate with BCVA, refuting the notion that thicker preoperative corneas portend poor prognosis and supporting timely intervention irrespective of oedema severity.[8]

Endothelial cell survival

Twelvepercent cell loss at six months compares favorably with 20–30 % reported by Brockmann[13] and Price[7], possibly reflecting gentle donor handling and conservative air fill. Longterm followup will clarify whether this advantage is sustained.

Complications

Our 5.6 % rebubbling rate is lower than the 10–15 % metaanalytic average[14], likely attributable to routine intraoperative peripheral tapping and postoperative supine positioning. Absence of graft rejection corroborates DMEK's immunological advantage.[7]

Subgroup analysis

Although eyes with final CCT < 625 µm showed nonsignificant BCVA superiority, the trend favors aggressive management of residual oedema, be it by additional air injection or topical hypertonic. Larger cohorts may detect significant differences.

Strengths and limitations

Strengths include prospective design, masked measurements, singlesurgeon uniformity and complete 24week followup. Limitations are singlecenter scope, modest sample and absence of endothelial functional assays such as central corneal thickness recovery time. Lack of a control arm (e.g., ultrathin DSAEK) precludes direct modality comparison.

Clinical implications

Routine pachymetry offers an inexpensive, objective marker for postoperative surveillance, aiding early identification of failing grafts. Surgeons should not delay DMEK on the basis of markedly thick corneas if the stroma is optically clear.

Future directions

Longterm (> 5 y) observation will elucidate the durability of the CCT–BCVA relationship. Incorporating intraoperative OCT may further reduce detachment rates. Adjunct pharmacotherapies promoting endothelial regeneration warrant exploration.

V. Conclusions

Postoperative, but not preoperative, central corneal thickness is strongly associated with visual acuity six months after DMEK. Prompt surgery and vigilant postoperative care that achieve rapid corneal deturgescence optimise functional outcomes.

Competing Interests: The authors declare that they have no competing interests.

Ethics Approval: The study was approved by the Institutional Ethics Committee of SMS Medical College and Attached Hospitals, Jaipur (Ref. No. 1379, dated 30-09-2023), in its meeting held on 07-10-2023. All procedures complied with ICMR and NDCT (2019) guidelines.

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