Corneal Thickness Results after Femtosecond Laser Assisted Descemet Stripping Automated Endothelial Keratoplasty

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Abstract

This prospective interventional case series study was applied on twenty eyes of nineteen patients with bullous keratopathy.

The aim of this study is to evaluate the central corneal thickness change after femtosecond assisted DSAEK on bullous keratopathy and Fuch's dystrophy.

All patients underwent the surgery under local anesthesia and were performed by highly experienced cornea surgeons. Best corrected visual acuity were recorded 1.2,3 weeks and 1,2,3 months postoperatively.

Results of this study showed a significant improvement in the corneal thickness measured by anterior segment OCT, with maximum decrease in the thickness in the first one month, and to a lesser extend two and three months after the procedure.

Key Words: Central corneal thickness – Bullous keratopathy – Femtosecond laser – Descemet stripping automated endothelial keratoplasty – Fuch’s Dystrophy.

Introduction

The endothelium is a single layer of cells present on the back of the cornea. The site of the metabolic pump is within the lateral cell membrane; it is temperature dependent, it is associated with the enzyme Na+/K+ ATPase, and it is inhibited by ouabain. Endothelial cells produce a basement membrane (the descemet membrane), and they are of neuroectodermal origin. Cell density at birth can be as high as 7500 cells/mm², decreasing to an average of about 2500-2700 cells/mm² in older adults. Endothelial cells are not capable of significant mitotic activity. The normal rate of endothelial loss after age 20 years is approximately 0.5% per year. Surgical trauma as pseudophakic and aphakic bullous keratopathy, inflammation, and corneal dystrophies as Fuchs dystrophy can accelerate this normal aging loss. The final common pathway in the development of bullous keratopathy is damage to the corneal endothelium; when the cell density reaches a critically low level of about 300-500 cells/mm², fluid begins to accumulate within the cornea. As a result, the cornea loses its transparency and the individual suffers a reduction in vision [1].

Fuchs Endothelial Dystrophy (FED) is a condition in which there is premature degeneration of corneal endothelial cells [2].

Descemet Stripped Automated Endothelial Keratoplasty (DSAEK), has become the preferred method of treating endothelial dysfunction, after Penetrating Keratoplasty (PKP) had long been the gold standard for treatment due to its limitations including delayed visual recovery and unpredictable refractive changes [3].

Aim of the work: Is to evaluate the central corneal thickness change after femtosecond assisted DSAEK on bullous keratopathy and Fuch’s dystrophy.

Patients and Methods

This is a prospective interventional case series study applied on twenty eyes of nineteen patients who underwent a totally femtosecond assisted DSAEK. This study was carried out from November 2014 to December 2015.

Patient selection:

Adult patients with pseudophakic corneal decompensation, less than 12 months duration and patients with fuch's endothelial dystrophy grade V.
We excluded:
- Corneal dystrophies other than fuchs.
- Central and paracentral corneal scars.
- Eyes with uveitis, glaucoma, or retinal vascular occlusive diseases.
- Eyes with optic nerve diseases.
- Eyes with retinal detachments.

Patient counseling and consent:
Patients expectations and wishes were discussed. An informed consent was obtained from the studied patients after discussing the surgical details of the technique and elaborating expected results and any possible complications.

Pre-operative assessment:
All patients underwent complete ophthalmological examination before surgery, including:
- Measuring corneal thickness with the anterior segment OCT and corneal pachymetry.
- Best corrected visual acuity (according to the snellen VA chart).
- Slit lamp examination.
- Assessment of the IOP.

Surgical technique:
Donor tissue preparation: Corneoscleral buttons of endothelial cell count not less than 2300 cells/mm$^2$ were mounted on a disposable artificial Anterior Chamber (ACC) (Barron disposable ACC (katena, Inc). Infusion of Balanced Saline Solution (BSS) to make the pressure high (between 60-65 mmHg), online pachymetry (WaveLight® EX500) is made to measure the Central Corneal Thickness (CCT).

A 200 KHz femtosecond laser (Alcon WaveLight FS200 Femtosecond Laser) was used to resect the posterior stromal tissue. The laser is programmed to make a 150μm thickness lenticule from the endothelial side measured from the central cornea, of a diameter of 7.50mm and angle 90º.

The patients corneal thickness is measured preoperatively by anterior segment OCT (DRI OCT Triton swept source OCT-topcon), Oculyzer (WaveLight®, city) and after application of topical anesthetics and removal of the epithelium the CCT is re-measured by online pachymetry.

Then the patient is sent to the operative theater where is given a peribulbar anesthesia, sterilization of the skin by Povidone-iodine (betadine) 10% draping of the eyelids and the eyelashes and then conjuctival wash with betadine 5% is made.

First a 20 gauge MVR incision is made at 6 o’clock through which a trypan blue 0.06% is injected to delineate the precut lenticule. An anterior chamber maintainer is inserted through this incision attached to a bottle of BSS with a bottle height that gives a 20mmHg pressure. The patients cornea is dissected by the femto second laser exactly as the donor’s cornea by the same technique and measures.

A 2.80mm keratome incision is made at 12 o’clock, anterior chamber wash by BSS then with the anterior chamber maintainer is turned on. An inverted (reversed) sinskey hook is brought to the anterior chamber to dissect the remained attachments of the precut then the lenticule is withdrawn by a toothed forceps from the anterior chamber. The extracted lenticule is inspected in front of the patient’s cornea to make sure that there are no missing parts.

The donor’s cornea is inverted so that the endothelial side becomes up then by the microforceps (end gripping forceps) the precut lenticule is stripped from the donor’s cornea and been transferred to the busin’s glide so that the endothelial side is up. A 5mm keratome incision is made at the nasal part of the patient’s cornea and a MVR incision is made just opposite to it. The busin’s glide is been put just at the 5mm keratome incision while the forceps crosses the anterior chamber from the MVR incision and gets out of the keratome incision to grasp the lenticule at that stage the anterior chamber maintainer is turned off. The forceps withdraws the lenticule to the anterior chamber and as soon as the lenticule is in the anterior chamber, the irrigation is turned on so the jet of BSS helps in unfolding of the lenticule.

The fluid flow will push the lenticule to the back of the patient’s cornea, and the keratome incision is closed by 10-0 sutures. A big air bubble is injected in the anterior chamber, at an intraocular pressure around 30mmHg milking of the lenticule from above the cornea is made to place the lenticule in the recess. After 10 mins the air bubble is reduced so papillary block doesn’t occur.

The patient remains strictly face up for 24 hours. Postoperative treatment is in the form of topical antibiotics, steroids and anti-glaucoma medications.

Postoperative evaluation:
Central corneal thickness is measured, slit lamp examination; the lenticule position is checked, the IOP is measured, and the epithelial healing by
fluorescence staining, signs of infection is looked for.

**Results**

**Patients demographics:**
- Mean patient age (±SD) was 61±7.94 years (range 45-69).
- 11 females and 8 males.
- Sixteen eyes were pseudophakic at the time of DSAEK and two aphakics.
- In two patients, DSAEK was combined with phacoemulsification and IOL implantation.
- One patient had a phakic anterior chamber IOL that causes the corneal decompensation that was removed phacoemulsification was made and IOL was implanted in the bag.
- One patient with fuch’s dystrophy that had DSAEK combined with phacoemulsification.

**Outcomes:**

| Table (1): Shows the mean, standard deviation, median, maximum, and minimum for the central corneal thickness. |
| Mean | Standard Deviation | Median | Maximum | Minimum |
| PreOCT | 900.76 | 113.41 | 901.00 | 1097.00 | 733.00 |
| OCT1M | 622.18 | 39.92 | 632.00 | 689.00 | 560.00 |
| OCT2M | 566.53 | 26.74 | 561.00 | 624.00 | 500.00 |
| OCT3M | 562.06 | 37.38 | 557.00 | 645.00 | 455.00 |

W = Week. OCT = Central corneal thickness measured by OCT. M = Month. PreOCT = Preoperative CCT.

Results of this study showed a significant improvement in the corneal thickness measured by anterior segment OCT (DRI OCT Triton swept source OCT-topcon), with maximum decrease in the thickness in the first one month, and to a lesser extend two and three months after the procedure. (Fig. 1, Table 2).

![Change in central corneal thickness in postoperative visits](image)

**Discussion**

The currently used technique for the DSAEK there is an increase in corneal thickness because posterior donor stroma is added without removal of any recipient stroma, [4] in our study where an equal stroma is removed from the recipient’s cornea not causing an extra burden with the over swollen edematous cornea on the newly implanted endothelium.

Regarding DMEK that don’t increase the total corneal thickness and don’t introduce a new stromal interface (the main problem facing our study) although a current challenge is that Descemet’s membrane is quite fragile without attached stroma to provide support, so a significant percentage of donor corneas are lost while harvesting the membrane or by subsequent primary graft failure. DMEK needs a well experienced surgeon with a steep learning curve [5].

In a study by Chaoron et al., documented the histological finding of a corneal button removed from a patient after DLEK, they found a fibrotic repair limited to the peripheral margins that gives advantage for DLEK over DMEK in form of postoperative lenticule stabiltiy [6].

The main problem with the side sealing of the graft/host junction, air can be trapped between the graft and the posterior stroma, causing what we call a double bubble sign, this may lead to delay in corneal clarity over the first 48 hours and compromises graft to stroma attachment in the early postoperative period, this problem is treated by venting, a positive sign for venting success is the corrugation at the donor’s lenticule and that the donor’s lenticule fits in its place properly.

Another issue we faced was the thickness Disparity when cutting the posterior recipient defect with the exact thickness as the graft; you have a perfect match in the immediate postoperative period. But over time, the implanted graft succeeds in clearing the overlying stroma from its edema.
So the cornea shrinks, and the posterior defect becomes shallow. This can lead to minimal graft protrusion over time, which is still better than the total graft add on in manual DSAEK. This is overcome by cutting a deeper posterior defect than the graft thickness (180µm for a 120µm graft).

There were no donor lenticule preparation complications that was reported in cases of manual dissection or microkeratome preparation like excessively thickened donor posterior lenticules, donor tissue perforation [7].

We had four recipient corneas with uneven femtosecond cut through there cornea and even areas with no cleavage were the descement and endothelium were removed manually and that was due to the uneven corneal thickness with bullous keratopathy especially in long standing corneal edema, this may be due to the non equal separation of the corneal lamella by the water pressure. This is compounded by any attempt of stromal fibrosis. This is evident also in areas with thickness above 1200µm, (as that’s the upper limit for the femtosecond penetration). As we implant the perfectly regular graft in the defect, it can be deeply imbedded in one part and flush or slightly protruding in another, but that complication reduced after we added the use of the corneal thickness and femtosecond application after removal of the epithelium. The corneas with the uneven cut didn’t show lenticule detachment.

The influence of graft thickness on VA has been the subject of several studies, yet remains controversial. Many studies have reported a significant relationship between graft thickness and VA after DSAEK. Neff et al. [8] retrospectively analyzed 33 cases of DSAEK using precut tissue. The eyes were divided into thin and thick graft groups, the thin graft group had a significantly better postoperative best spectacle-corrected visual acuity (BSCVA) than the thick graft group (p<0.01).

Pogorelov et al. [9], measured central corneal and graft thickness 6 months after DSAEK in 15 eyes. They concluded that BSCVA correlates significantly with both central corneal and graft thickness (Pearson correlations −0.745 and −0.589, respectively, p<0.05) [9]. Chen et al., measured corneal thickness with ultrasonic pachymetry 6 months after DSAEK. They found a weak, but statistically significant, correlation with postoperative BSCVA (r² = 0.117, p=0.001) [10].

References


