Original article

Functional results after endothelial keratoplasty: three years of experience

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ARTICLE INFORMATION

ABSTRACT

Objective: To study the refractive and visual results after Descemet's stripping automated endothelial keratoplasty (DSAEK).

Methods: Retrospective study of 75 eyes in 67 patients with Fuchs' endothelial dystrophy or bullous keratopathy operated on in the Instituto de Oftalmología La Arruzafa from March, 2007 until March, 2010. Phacoemulsification and IOL implantation was involved in 30 cases. We divided all cases into three groups, depending on the potential visual acuity: A (≤ 0.1), B (0.1-0.5) and C (≥ 0.5). Uncorrected distance visual acuity (UCVA), corrected distance visual acuity (CDVA) and refraction were measured.

Results: Mean CDVA improved 3 lines compared to preoperative values (P<.01). Astigmatism increased by 0.5 dioptres (P=.21). A slight myopic change was found in cases where the donor disc was≥8.5mm, as well as in the cases in which phacoemulsification was associated. No correlation between CDVA and donor disc thickness was found. In the group of patients who only had corneal oedema, the mean CDVA was 0.8. No patients ended with less than 0.6 of CDVA and the mean UCVA was 0.5.

Conclusions: After DSAEK, CDVA improved with a slight hyperopic change, without significant changes in astigmatism. Donor disc thickness does not influence the CDVA. DSAEK is an effective surgical technique to restore a good visual acuity in cases with corneal oedema due to endothelial failure.

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Introduction

Penetrating keratoplasty (PK) has been the technique of choice for treating endothelial failure for the past half century. However, this procedure is not free of drawbacks, including prolonged visual rehabilitation, high astigmatism, complications related to sutures, infectious keratitis, incision dehiscence, endothelial rejection and even the possibility of expulsive hemorrhage. In recent years, endothelial keratoplasty has evolved since Gerrit Melles published in 1998 the first successful case of corneal transparency restoration by changing the posterior layers of the cornea in a patient with bullous keratopathy.1,2 A few years later, Mark Terry modified the instruments and began to publish significant series of patients.3,4 Performing a descemetorhexis,5 as well as obtaining a donor disc by means of keratotomy performed with a microkeratome over an artificial anterior chamber greatly increased the reproducibility of the technique and facilitated a more homogeneous bonding of both substrates (donor and receiver).6 This technique has become known as DSAEK (Descemet’s stripping with automated endothelial keratoplasty) and is at present carried out in many centers as an alternative to PPK for treating corneal edema due to endothelial dysfunction. In our center we have been performing DSAEK operations for 3 years and the objective of this paper is to publish our refractive and visual results and compare these with other previously published series.

Subjects, material and method

The clinical records of patients intervened since March 2007 up to March 2010 with the DSAEK technique were retrospectively analyzed. All the operations were carried out according to the Ethical Principles for Medical Research in Humans of the Helsinki Declaration of the World Medical Association (59th Gen. Assembly, Seoul, Korea, October 2008). The surgical indications in all cases was corneal edema due to Fuchs endothelial dystrophy or bullous keratopathy. The study comprised 75 eyes of 67 patients (therefore, 8 patients were bilateral), 32 males and 35 females. All fulfilled at least one month of evolution: the mean ± standard deviation (range) was of 15.4±10.59 (1-36) months (M±SD [range]). The mean age was 66± 12.66 years (22-82). Four patients had a failed PPK (SDAEK after PPK) and in 30 cases (40%) phacoemulsification and IOL implants was associated in the same operation. Eight of the patients were aphakic or exhibited anterior chamber (AC) lens. The mean preop corrected visual acuity (CVA) was of 0.22±0.23 (0.01-1.0) and the mean preop reflective astigmatism was of 1.54±1.34 (0-8) dioptres. After the surgery, the patients were assessed the following day, at day 3, one week, one month, and at 3, 6, 12, 24 and 36 months (in the longest follow-up case), except when a complication advised additional checkups. Each assessment measured the uncorrected visual acuity (UCVA), refraction and CVA. The results shown in this paper are those of the last assessment of each patient. The data were included in an Excel spreadsheet and subsequently
processed with the SPSS statistical application (SPSS v. 17. Inc. Chicago, USA.). The parameters of the analysis were mean comparisons to determine the existence of significant differences before and after the intervention, and the correlation and regression (both to determine the existence of linear or nonlinear relationships between the compared variables). For comparing the mean values, the following parametric methods were utilized: T test at 95% ($\alpha=0.95$) for independent samples (this analysis was utilized as a pre-test), T test at 95% ($\alpha=0.95$) for related samples (because the variables are measured before and after the intervention) and ANOVA variance analysis of one factor ($\alpha=0.95$) (to confirm or discard the results obtained in the previous test). The nonparametric tests of Wilcoxon, Friedman and Kendall ($\alpha=0.95$) were utilized to check the homogeneity of the variables before and after the treatment. For the linear correlation and regression analysis the following methods were utilized: Pearson -parametric- ($\alpha=0.95$) and nonparametric (Kendall’s Tau b and Spearman’s Rho) ($\alpha=0.95$).

**Surgical technique**

The surgical technique has been sufficiently described in numerous papers.6-9 It is necessary to work on a button with a scleral attachment adapted to the artificial anterior chamber with a total diameter of 16mm. The cornea must have a target to target distance of at least 11mm. The donor tissue is assembled over the artificial anterior chamber developed by Ziemer Ophthalmic Systems AG (Switzerland) (fig. 1) for the Amadeus II microkeratome. A complete anterior stroma disc is obtained leaving a posterior stroma substrate of between 100 and 200µm. The button is located on the Hessburg-Barron trephination with the endothelium facing upwards. In this manner we obtain a disk with posterior stroma, Descemet’s membrane (DM) and endothelium. Subsequently the receiving corneal epithelium is marked (the receiving eye has been blocked with retrobulbar anesthesia and dilated with cycloplegic and phenylephrine) with the same punch utilized for trephinating the donor cornea (stained with gencian purple): this mark, centered in the pupil, facilitates a correct position of the donor lamella. Generally, we carry out 2 paracentesis to manipulate the donor cornea with less trauma and subsequently perform phacoemulsification in the usual manner (provided this procedure is necessary), trying to penetrate through the more curved meridian to reduce astigmatism. After introducing the IOL, the anterior chamber is pressurized with viscoelastic and, with the pupil dilated, we would have sufficient fundus reflection to carry out the descemetorhexis: we mark and detach DM at 360° under the line made with the punch in the epithelium. This maneuver can be performed with custom instruments designed by many authors (Sinskey Katena hook (K3-5002. Katena Products, Inc., Denville NJ, USA) oriented opposite to the normal orientation. We prefer to use an insulin needle with the tip cut and bent 90° in the distal end and 45° in the proximal end. After detaching the DM in the periphery, we can complete its removal with a Melles scraper (50.212-D, DORC, Zuidland, The Netherlands) or a John tweezer (AE-4962. Asico LLC, Westmont, IL). Subsequently, with the same instrument used for marking the DM, we perform a posterior stroma scraping at 360° and a width of 1.5mm inside the bed created by the descemetorhexis. With this maneuver we exposed the posterior stroma fibers in the periphery, thus considerably strengthening the adhesion of the donor disc in that area. After suctioning all the AC viscoelastic, we proceeded to close the pupil with acetylcholine and increase the main incision to 5mm. At this point the donor disc is introduced and there are several ways to do it. In the first 6 cases we utilized the technique based on folding the lamella in the fashion of a Mexican taco and introduce it with tweezers. The technique utilized in the last 69 cases involved a sort of injector-glider designed by Maximo Busin (ref. 19098. Moria SA, Anthony, France) (fig. 2). In this case, we must make an incision opposite to the main one of about 2.5-3mm. Through one of the supporting paracentesis we introduce an AC holder, after which the donor lamella is deposited in the blade of the glide...
with the endothelium upwards and without using viscoelastic over it. With the Busin tweezers Busin (ref. 2004. Moria SA, Anthony, France), we traction one of its edges until it appears through the end of this device, which is rotated 180° and brought closer to the main incision. The same tweezers is introduced through the opposite incision and goes through the entire AC until its end appears through the main incision. At this point, the edge of the donor disc is taken by the tweezers and with an opposite movement the lamella is introduced in the AC (fig. 3). Without the aid of air, it is deployed by the same pressure of the AC holder, which is withdrawn after the maneuver has been completed. As the tissue introduced in the AC usually remains unattached, we must aid ourselves of an air bubble introduced through the paracentesis to adhere it to the posterior stroma. For its definitive deployment we inject an air bubble introduced through the paracentesis to achieve it with the posterior stroma. For its definitive deployment we inject an air bubble through the opposite paracentesis and the donor lamella opens and remains adhered to the posterior stroma of the receiver. With the same instrument utilized for performing the descemetorhexis, we centre the disc in the previously marked substrate in order to finally pressurize the AC with air and give one stitch in the main incision. In this moment, we place viscoelastic over the corneal epithelium and, with the aid of a thick spatula, we drain the liquid which could remain in the interface (performing centrifugal pressing movements over the corneal surface) to leave the patient in supine position for about 15 min. in the surgery stretcher. After this period, we extract about 40% of the air bubble from the AC to avoid pressure increases in the immediate postop. Subsequently, the patient is taken to the ward to remain immobilized for at least 2-3 hours to reduce the possibility of a disc dislocation.

The stitches were removed one month after the surgery. In the first 2 weeks of the postop period we utilized prednisolone acetate and ofloxacine every 4 hours. After this period, we switched to fluorometholone 1% 4 times a day, diminishing the frequency of the drops through a 4 month period.

**Results**

In 4 of the 75 cases the patient follow-up could not be completed for various reasons (table 1). The pre- and postop refractive and functional results are shown in table 2. The mean postop CVA improved 3 lines against the preop values, with this difference being statistically significant. The refractive astigmatism has increased a mean value of half a dioptre, but this change was not statistically significant.

The mean corneal disc thickness in our series of patients (measured with OCT-Visante one month after surgery) was of 165±44 (88-263) µm; diameter of the grafts varied between 7 and 9 mm, with 81% being of 8-8.5 mm searching for differences in the spherical equivalents between the patients who received an 8 mm or smaller graft against those who received an 8.5 mm or larger graft, a slight myopization is observed in the larger diameter graft group. The same occurs with the cases in which phacoemulsification was associated, which exhibit a slight tendency to myopic spherical equivalent (fig. 4). Comparing global postop CVA with corneal disc thicknesses we found an extremely low correlation index (fig. 5).

### Table 1 – Causes of exclusion from the study for 4 patients

<table>
<thead>
<tr>
<th>Cause of exclusion</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>One case of primary graft failure due to excessively thin lenticle and presence of striae (awaiting a new SDAEK)</td>
<td></td>
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<tr>
<td>Two cases of reversion to PPK:</td>
<td></td>
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<tr>
<td>- One in the first week due to intra-op expulsion of the disc</td>
<td></td>
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<tr>
<td>- 1 in the first 3 months due to early failure after considerable surgical trauma (primary graft failure)</td>
<td></td>
</tr>
<tr>
<td>One case of midterm essay yet due to surgery trauma and patient follow-up loss</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2 – Pre- and post-op refractive data

<table>
<thead>
<tr>
<th></th>
<th>Pre-op M±SD (range)</th>
<th>Post-op M±SD (range)</th>
<th>Statistical significance (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spherical equivalent</td>
<td>Not applicable as the majority of patients could not undergo refraction pre-op</td>
<td>-0.17±1.87 (+3.50-5.25)</td>
<td></td>
</tr>
<tr>
<td>Sphere</td>
<td>Not applicable as the majority of patients could not undergo refraction pre-op</td>
<td>0.81±2.13 (+6.00-3.50)</td>
<td></td>
</tr>
<tr>
<td>Cylinder</td>
<td>1.54±1.34 (0-6)</td>
<td>2.01±1.52 (0-8.0)</td>
<td>p=0.21</td>
</tr>
<tr>
<td>Corrected visual acuity</td>
<td>0.22±0.23 (0.01-1.0)</td>
<td>0.53±0.30 (0.05-1.2)</td>
<td>p=0.01</td>
</tr>
<tr>
<td>Uncorrected visual acuity</td>
<td>Not applicable as the majority of patients had uncorrected visual acuity values under 0.1</td>
<td>0.30±0.21 (0.01-0.85)</td>
<td></td>
</tr>
</tbody>
</table>
Finally, dividing our 75 cases according to the visual potential of each, we have established 3 groups of patients (fig. 6):

- group A: patients with visual potential of 0.1 or less due to the fact that they exhibited severe age-related macular degeneration (or any other maculopathy), or were patients with deep amblyopia, severe corneal stroma alterations which we knew would not allow a good CV or patients with terminal glaucoma.

- group B: patients with visual potential between 0.1 and 0.5 due to exhibiting slight age-related macular degeneration or patients with slight-moderate amblyopia or with slight-moderate alterations of the corneal stroma and/or slight myopia and/or astigmatism.

- group C: patients who only exhibited corneal edema without any other associated ocular condition.

In terms of CVA, the differences between these 3 groups of patients are obvious. In addition, in group C (patients who only exhibited corneal edema without any other associated ocular condition), which comprised 22 patients, the mean CVA was almost 0.8. None of the patients remained below 0.6 CVA and the mean UCVA was of nearly 0.5.

Discussion

In our series of patients, both in terms of spherical equivalent and sphere, the mean is close to emmetropia, although we found a broad range due to the preop characteristics of the patients, some of whom had high myopia and high hypermetropia. The same occurred with astigmatism. It must be taken into account that the patients having a high cylinder exhibited PK preop. It is important to note that, in contrast with PK, this is a procedure which slightly tends to hyperemmetropization^{9-11} but which, when performing associated phacoemulsification, we are able to adjust the power of the IOL selecting the IOM for an objective between (-1.25) and (-1.50) dioptres to remain as

Figure 5 – No influence of the donor disc thickness was found (measured with OCT one month after surgery) and final corrected visual acuity.
close as possible to emmetropia as suggested by Terry. In our series, the cases which had phacoemulsification associated exhibited slight myopization, probably as a result of a slight hypercorrection in said adjustment, because it is frequent not to have the actual keratometry of the patients and having to select the keratometry of the other eye. The fact that the group of patients with larger diameter grafts exhibited slight myopization could be due to the fact that the posterior curvature in the periphery is different to that of the smaller diameter grafts, although this is mainly a conjecture. In what concerns astigmatism, the mean induction was minimal and the differences vis-à-vis the preop are not significant (similar to the data reported in the literature for SDAEK). The mean postop CVA (taking into account the 3 groups of patients) improved 3 lines vis-à-vis the preop values, with these differences being statistically significant. The postop CVA is within the range observed in the literature, taking into account that this is a heterogeneous group of patients with associated ocular conditions (amblyopia, high astigmatism, age related macular degeneration, advanced glaucoma, corneal stroma with fibrotic changes, etc.).

Comparing the overall postop CVA with the corneal disc thickness (measured with OCT one month after the surgery), we found an extremely low correlation index, which implies that the corneal graft thickness does not influence the final visual acuity. This finding has already been established by Price.

In CVA terms, the differences between the 3 groups of patients according to the visual potential are obvious. The important fact for us is that in group C (patients who only exhibited corneal edema without other associated ocular conditions) which comprised 22 patients, the mean CVA was nearly 0.8. None of the patients remained below a CVA value of 0.6 and the mean UCVA was of nearly 0.5.

keratopathy. The mean UCVA was of 0.3, also with a broad range and, although this data may seem irrelevant, it has some importance because having a mean UCVA of 0.3 in a group of patients that includes cases retinal alteration cases means having many more patients close to emmetropia and the majority without any irregular astigmatism components. As conclusion, we believe that SDAEK is an effective technique for treating corneal edema secondary to endothelial alteration, with functional results above those published for.

Conflict of interest

None of the authors have declared any conflict of interest.

References


