Original article

Deep keratoconus:
Penetrating keratoplasty versus deep anterior lamellar keratoplasty with Melles technique

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ABSTRACT

Objectives: To evaluate the effectiveness of deep anterior lamellar keratoplasty (DALK) using Melles technique (technique B) in patients with advanced keratoconus versus a classic technique, penetrating keratoplasty (technique A).

Methodology: Retrospective descriptive comparative study between technique A and technique B in homogeneous groups.

Results: Best corrected visual acuity (Snellen test decimal scale) was 0.77 ± 0.32 for group A and 0.62 ± 0.29 for group B, with no statistically significant differences. The mean spherical final refraction in group A was 1.73 ± 5.1 diopters, and the mean spherical equivalent was −3.92 ± 5.1. Technique B group gave values −2.67 ± 4.02 diopters and −4.55 ± 4.08 diopters, respectively, with no statistically significant differences. The residual cylinder after removal of the sutures was 4.47 ± 2.47 diopters for group A and 3.77 ± 1.63 for group B, with no statistically significant differences.

Conclusion: No statistically significant differences were found for any of the studied variables when comparing both groups using the t-test for independent samples. More studies on the homogeneity and residual stromal bed thickness could provide the key to determine whether this technique is closer to the visual acuity of penetrating keratoplasty or DALK by a descemet technique.

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Trasplante de córnea en queratocono: queratoplastia penetrante versus queratoplastia lamellar anterior profunda con técnica de Melles

RESUMEN

Objetivos: Evaluar la eficacia de la queratoplastia lamellar anterior profunda (DALK) mediante técnica de Melles (técnica B) en pacientes con queratocono avanzado en comparación con la técnica clásica de queratoplastia penetrante (QPP) (técnica A).

Metodología: Estudio retrospectivo descriptivo comparativo entre la técnica A y la técnica B en grupos homogéneos.

Resultados: La agudeza visual con corrección (test de Snellen, escala decimal) ha sido de 0,77 ± 0,32 para el grupo A y de 0,62 ± 0,29 para el grupo B, no siendo diferencias estadísticamente significativas. El defecto refractivo esférico medio en el grupo A fue de −1,73 ± 5,1 dioptrías y el equivalente esférico medio de −3,92 ± 5,1 dioptrías. El grupo B presentó valores de −2,67 ± 4,02 dioptrías y −4,55 ± 4,08 dioptrías, respectivamente, no habiendo diferencias para estas variables en ambos grupos. El cilindro residual una vez retiradas las suturas fue de 4,47 ± 2,47 dioptrías para el grupo A y de 3,77 ± 1,63 dioptrías para el grupo B, sin ser estadísticamente significativas.

Conclusión: No se han encontrado diferencias estadísticamente significativas para ninguna de las variables estudiadas al comparar ambos grupos mediante la t de Student para muestras independientes. Más estudios acerca de la homogeneidad del lecho estromal residual y del espesor del mismo pueden aportar las claves para que esta técnica se acerque a las agudezas visuales de una QPP o una DALK mediante técnica descemética.

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Introduction

Keratoconus is a non-inflammatory disease which involves ectasia, expressing in its early stages by means of changes in patient refraction. In some cases, vision can be improved with spectacles, in other cases contact lenses and in a high number of cases it is necessary to apply surgery to improve the quality or quantity of vision. In early stages of the disease, intra-corneal rings have been implanted to improve visual acuity as well as to stabilize the cone. This technique has also been used in advanced keratoconus with optimum results. Accordingly, during the progression of corneal ectasia in this pathology, it has been demonstrated that corneal collagen cross-linking can be effective.

When none of the alternatives mentioned above are effective or there is no indication because the disease is at very advanced stages, the solution is corneal transplant. For many years, the surgical treatment of choice in advanced keratoconus has been penetrating keratoplasty (PK). Between the decade of the seventies and nineties, some authors performed epikeratophakia but this intervention was subsequently abandoned due to poor results as the non-homogeneous surface generated irregular astigmatism which did not produce satisfactory visual acuity. Later on, deep anterior lamellar keratoplasty (DALK) was introduced as an alternative to PK with the idea of maintaining the receptor endothelium.

Various techniques have been used to maintain the receptor endothelium: manual dissection, hydrodissection, viscodissection or air dissection (big-bubble). This study compares PK with DALK by means of the manual dissection technique known as the Melles technique.

Material and methods

This retrospective study included patients intervened between 2002 and 2011 with keratoplasty (penetrating or deep anterior lamellar with the Melles technique) in the Arruzafa hospital in Córdoba for advanced keratoconus not susceptible to other techniques for improving their corneal pathology. The study complied with the principles of the Helsinki declaration. In all cases, the minimum follow-up period exceeded one year, and the refractive and visual acuity analysis were carried out after removing all the sutures. On the basis of these criteria, 41 eyes of 36 patients were included in the study, 20 eyes underwent PK and 21 DALK using the Melles technique.

Group A comprised 20 eyes with advanced keratoconus which underwent PK, of which 12 were performed due to failure in achieving a big bubble and requiring a switch to penetrating surgery. Group B comprised 21 eyes which underwent DALK using the Melles technique. Two eyes of group A and 3 eyes of group B were lost during the follow-up. The groups were homogeneous in what concerns age, sex and follow-up time (Table 1).

The penetrating technique was performed marking the center of the cornea and removing the complete thickness thereof with a Hessburg-Barron trepan (Katena Products, Inc., Denville, United Kingdom), completing a 360° keratotomy using corneal scissors. A 8.5 mm trepan was utilized in all
cases. The cone, as detected by the Fleischer ring, was included in the trepanning area. All the cases were sutured with 10.0 nylon with discontinuous stitches. Also in all cases antibiotic treatment was administered for 2 weeks (moxifloxacin 4 times a day) and corticoid treatment (dexamethasone 4 times a day during 2 weeks and subsequently 1% fluorometholone 4 times a day during one month, diminishing one drop per month during 3 additional months).

The lamellar technique was performed using the same trepan to achieve partial keratotomy and generating a substrate as homogeneous and deep as possible using the spatulas designed by Melles.\textsuperscript{12} The donor endothelium was withdrawn after staining with trypan blue, and the suture between the donor and receptor was performed as in penetrating surgery.

All the patients were examined the following day, after one week, one month, and at months 3 and 6. Subsequently, depending on the corneal astigmatism, they were examined monthly until achieving an anastigmatic cornea to the fullest possible extent. After one year of evolution, none of the eyes had sutures and were examined twice a year unless other conditions required otherwise.

The results obtained with both techniques were analyzed assessing best corrected visual acuity, spherical refractive defects, spherical equivalent and refractive cylinder (Table 2). In addition, complications were analyzed (rejection, suture dehiscence, etc.) in each of the 2 groups. All the analyses were performed using SPSS, version 20.0 (SPSS, Inc., Chicago, USA). A descriptive analysis was performed calculating mean values ± typical deviation as well as range. The comparison between the 2 groups was performed with the t for student analysis for quantitative data and the Chi square for quantitative data. A “p” value of 0.05 or lower was taken as statistically significant.

### Results

The mean follow-up was of $4.85 ± 3.28$ years (between 1 and 10.5 years) for group A and $4.21 ± 1.9$ years (between 1 and 7 years) for group B.

Corrected visual acuity (Snellen test, decimal scale) was of $0.77 ± 0.32$ for group A and $0.62 ± 0.29$ for group B. Excluding from the analysis the 3 group B patients who exhibited maximum potential visual acuity of 0.3, the mean visual acuity was of 0.67.

The mean spherical refractive defect in group A was of $−1.73 ± 5.1$ diopters while the mean spherical equivalent was $−3.92 ± 5.1$ diopters. Group B exhibited values of $−2.67 ± 4.02$ diopters and $−4.55 ± 4.08$ diopters, respectively. After removing the sutures, residual cylinder was of $4.47 ± 2.47$ diopters for group A and $3.77 ± 1.63$ diopters for group B (Table 2).

Group A exhibited 3 rejection episodes, one of which caused graft failure, while no rejections occurred in group B. In what concerns problems related to suture (dehiscence), 3 cases arose in group A and none in group B. Group A included a patient with Down syndrome which ended in evisceration due to repeated suture problems caused by continued manipulation by the patient. Group B comprised 3 patients with the same syndrome, with the 3 grafts remaining feasible up to the end of the follow-up period.

No statistically significant differences were found for any of the studied variables when comparing both groups with

### Table 1 - Gender distribution of patients included in both study groups.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK</td>
<td>12</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>%</td>
<td>60.0%</td>
<td>40.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Melles</td>
<td>15</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>%</td>
<td>71.4%</td>
<td>28.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Count</td>
<td>27</td>
<td>14</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>65.9%</td>
<td>34.1%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

### Table 2 - Results obtained in both techniques for best corrected visual acuity, spherical refractive defect, spherical equivalent and refractive cylinder.

<table>
<thead>
<tr>
<th>Technique</th>
<th>No.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Typ. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCVA</td>
<td>18</td>
<td>0.15</td>
<td>1.20</td>
<td>0.7778</td>
<td>0.32550</td>
</tr>
<tr>
<td>LogBCVA</td>
<td>18</td>
<td>−0.82</td>
<td>0.08</td>
<td>−0.1689</td>
<td>0.26942</td>
</tr>
<tr>
<td>Sphere</td>
<td>18</td>
<td>−18.00</td>
<td>5.00</td>
<td>−1.7361</td>
<td>5.16170</td>
</tr>
<tr>
<td>Spherical equivalent</td>
<td>18</td>
<td>−20.00</td>
<td>3.50</td>
<td>−3.9206</td>
<td>5.11904</td>
</tr>
<tr>
<td>Cylinder</td>
<td>18</td>
<td>0.75</td>
<td>10.00</td>
<td>4.4722</td>
<td>2.47471</td>
</tr>
<tr>
<td>No.</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCVA</td>
<td>17</td>
<td>0.10</td>
<td>1.20</td>
<td>0.6235</td>
<td>0.29321</td>
</tr>
<tr>
<td>LogBCVA</td>
<td>17</td>
<td>−1.00</td>
<td>0.08</td>
<td>−0.2638</td>
<td>0.25827</td>
</tr>
<tr>
<td>Sphere</td>
<td>17</td>
<td>−15.00</td>
<td>3.00</td>
<td>−2.6765</td>
<td>4.02411</td>
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<tr>
<td>Spherical equivalent</td>
<td>17</td>
<td>−16.75</td>
<td>0.50</td>
<td>−4.5588</td>
<td>4.08841</td>
</tr>
<tr>
<td>Cylinder</td>
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<td>0.00</td>
<td>7.00</td>
<td>3.7794</td>
<td>1.63431</td>
</tr>
<tr>
<td>No.</td>
<td>17</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

BCVA: best corrected visual acuity; LogBCVA: logarithmic BCVA value; LogMar: logarithm for maximum resolution angle.
the t for student for independent samples. The best corrected visual acuity was converted to the logarithmic scale without finding significance.

For the 2 complications (rejection and suture dehiscence), the analysis was close to significance with a “p” value of 0.06 assuming equal variances and of 0.08 without assuming equal variances. Larger sample sizes would be necessary for adequate assessment of significance in what concerns the analyzed complications.

Discussion

One of the advantages of lamellar surgery vis-à-vis PK is the preservation of the receptor endothelium which enhances graft feasibility as well as the absence of endothelial rejection.1,13,14

When comparing both techniques, lamellar surgery enables a drastic reduction of the complications associated to open surgery such as anterior synechiae, expulsive hemorrhage and endophthalmitis. In the series presented herein, the only patient with Down syndrome which underwent PK ended with evisceration, whereas none of the patients who underwent DALK experienced problems with graft survival. DALK appears to be a good choice in Down syndrome patients as it minimizes the possibility of complications due to permanent global closure. In addition to this, it must be taken into account that lamellar surgery requires significantly less stringent criteria for donor tissue.15

A number of techniques are possible for carrying out DALK, including the technique utilized in this study and described by Melles.16,17

The present study compared corrected visual acuity, spherical refractive defect, spherical equivalent and residual cylinder in both techniques, as well as the rate of complications involving rejection index and suture problems.

Many previous studies have published comparable visual acuity values between DALK and PK.18-24 This study has produced lower vision values in the DALK group because this technique leaves a residual stroma bed and causes poor visual quality, without it being a statistically significant difference. A range of heterogeneous techniques were applied in the group of publications that endorse similar visual acuity between both groups, as some authors have applied pres Descemetic while others have applied descemetic techniques. Other studies reported better results in patients with PK when compared with DALK patients, the latter being patients with residual stromal bed.25

Accordingly, it can be said that the results of this study are consistent with those published in the current references. In what concerns spherical equivalent and astigmatic error, the authors have not found significant differences between both groups.

A clear advantage of DALK is that it reduces the incidence of endothelial rejection. Trimarchi et al. found a 4% rejection prevalence after PK and 0% after DALK.26 In the present series, 3 rejection episodes occurred in the PK group and none in the DALK group. It is known that even when DALK preempts the possibility of endothelial rejection, other types of rejection may arise.

It can be concluded that the DALK technique as applied by Melles is a good technique for treating corneal pathologies which do not affect the endothelium. Probably, the fact of leaving residual stroma prevents DALK patients from achieving visual acuity values achieved by PK patients or those who underwent DALK procedure with the Anwar technique, even though no significant differences has been found in the analyzed series.

In the experience of the authors, the DALK according to the Melles technique is more reproducible than the Anwar technique, with considerably lower incidence of conversion to PK, as the receptor endothelium is maintained, thus ensuring lower complication rates. Additional studies on the homogeneity and thickness of the residual stromal bed should provide key information for this technique to achieve the visual acuity values of PK or DALK with Descemetic technique.

Conflict of interests

No conflict of interests has been declared by the authors.

REFERENCES