INTRODUCTION

Keratoconus patients have several alternatives for correcting their optical ametropias in order to achieve an increase in visual acuity. These are the use of glasses in the most incipient stages of keratoconus, contact lenses in moderate or even severe stages, and surgery if the patient cannot tolerate contact lens wear or if they do not provide sufficient visual acuity\(^1\). Corneal transplant is one of the usual surgical options for advanced keratoconus\(^2\). Keratoconus has being the main indication for penetrating keratoplasty in young adults\(^1\).

Between 10 and 20% of patients affected by keratoconus require a corneal transplant. Indications for penetrating keratoplasty are the following\(^1\)-\(^5\):

- Visual acuity below 0.5 in spite of wearing optical correction, whether glasses or contact lenses.
- Intolerance to contact lens wear.
- Excessive corneal thinning.
- Presence of a very decentred cone.
- Presence of recurrent keratitis.
- Presence of opacities in the visual axis.

Kirkness et al.\(^6\) reported that the most frequent indication was the difficulty in adapting to contact lenses or intolerance to them reported by the subjects.

This surgery is not, however, exempt from complications or limitations. The most serious is the transplant rejection. Others are the side effects derived from local/topical corticotherapy, and recurrence of keratoconus.

ARTICLE

Prenetrating keratoplasty in keratoconus treatment: long term results

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PURPOSE: To report the long-term outcomes of penetrating keratoplasty in the treatment of patients with keratoconus.


METHODS: Records of a retrospective case series of 57 eyes with keratoconus of thirty-four patients who underwent penetrating keratoplasty treatment from 2000 to 2007. We analized changes in visual acuity (UCVA and BCVA), refractive changes (sphere and cylinder) and the incidence of complications.

RESULTS: There was an improvement in visual acuity after the surgery both in UCVA and BCVA. Visual rehabilitation after surgery was slowly progressive. The residual cylinder decreased from $-6.57 \pm 2.15$ D to $-3.43 \pm 1.74$ D the fifth year after the surgery. Spectacles, and contact lenses corrected the residual refraction. The incidence of complications was lower.

CONCLUSIONS: Penetrating keratoplasty is indicated for the treatment of keratoconus, especially in severe stages. In spite that is a technique with the risk of serious complications, the results obtained are satisfactory.

KEYWORDS: Keratoconus; corneal ectasia; penetrating keratoplasty; corneal transplantation.

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The aim of this study is to analyse the medium-to long-term outcomes of penetrating keratoplasty in keratoconus treatment.

MATERIAL AND METHODS

We performed a retrospective analysis of keratoconus patients who underwent penetrating keratoplasty between the years 2000 and 2007. 57 eyes of thirty-four patients underwent surgery. Their demographic data were as follows: the patients’ age was between 19 and 53 years, mean age 37.25 ± 9.65 years. There was a predominance of males, 55.88% (18 men and 16 women). Of all the cases, 67.65% were bilateral. The mean time of performing transplantation in the second eye was around 5.2 years, either pre- or post-operatively. Ninety-eight per cent of the keratoplasty cases were due to low corrected visual acuity (<0.5) and in the remaining 2% of cases to intolerance to contact lens wear. The majority of the keratoconus cases reviewed were moderate to advanced (Stages III-IV of the Amsler eye test).

SURGICAL TECHNIQUE

The methodology applied at our hospital was the following:

Prior to surgery, a series of manoeuvres were carried out to avoid positive vitreous pressure that would complicate surgery, such as digital massage of the ocular globe, pilocarpine instillation, and intravenous mannitol administration.

First, the donor cornea was addressed, centring the incision in the visual axis. The incision was large enough to enable removal of all the keratoconic tissue, which in most cases is displaced downwards. This incision was made from the endothelial layer to the epithelial layer on a solid concave Teflon surface.

Then the recipient cornea was addressed as follows: with the Thornton radial marker, the cardinal points were marked to achieve the most symmetrical suture possible. The Hessburg-Barron trephine was positioned centrally, ensuring that it was perpendicular, and minimising the corneal protrusion in the interior of the trephine cylinder. Then a vacuum was applied to fix and centre it. Later the trephine was rotated until the presence of an aqueous humour was observed; perforation was then stopped and the trephine removed.

The anterior chamber was filled with viscoelastic and the recipient corneal button was cut with Castroviejo corneal scissors, and Vannas scissors were used to trim small ailerons on the recipient edge. The graft was placed over the recipient bed and then sutured using interrupted sutures with 10/0 monofilament and afterwards with an antitoric continuous suture with 10/0 monofilament.

Regarding the size of the transplant, the mean diameter of the graft of the patients who received surgery was 7.58 ± 0.37 mm and this diameter was situated between 7 and 8.25 mm (Table 1). The mean recipient diameter was 7.34 ± 0.38 mm, within a range of between 7 and 8 mm (Table 2). The difference in mean diameter between donor and recipient was 0.25 ± 0.11 mm situated between 0 and 0.50 mm.

With regard to existing suture techniques, the method used most frequently in this study was eight interrupted stitches with a continuous suture (Table 3).

After surgery, the patients were treated with topical and systemic antibiotics as well as topical corticoids. In 16.17% of the cases, the patients were given no type of systemic immunosuppression, in 25% of the cases systemic corticoids were administered to the patients, and in 58.83% of the cases the patients were prescribed another type of systemic immunosuppressors (83.83% of the patients were immunosuppressed). Oral Cyclosporine A was prescribed in 27.5% of the last group of cases, and mycophenolate mofetil was prescribed in 72.5% for at least one year.
RESULTS

Visual outcomes

There was an improvement in visual acuity (VA) compared with the situation prior to surgery in all the cases throughout the follow-up, with the exception of one case of a patient who suffered several rejection episodes and finally required a new transplant. Visual rehabilitation after surgery was slowly progressive. There was a considerable increase in both the mean corrected visual acuity (BCVA) after the first year and the percentage of patients who were able to reach a visual acuity of over 0.5; this situation was maintained throughout the follow-up. The progress of VA as well as the percentage of patients able to reach a VA of >0.5 during the follow-up is shown in Figures 1 and 2.

Spectacles, and above all contact lenses in most cases, corrected the residual refraction.

Refractive outcomes

Keratoconus patients often become myopic after penetrating keratoplasty. In our study, the mean spherical equivalent (SE) went from $-1.25 \pm 2.62$ dioptres (D) preoperatively to $+0.32 \pm 3.88$ D in the first month after surgery; $-1.08 \pm 3.26$ D in the third month postoperatively, and $-0.67 \pm 2.78$ D in the sixth month after keratoplasty. Mean SE values were $-0.99 \pm 3.00$ D one year after surgery, $-1.66 \pm 4.67$ at two years, $-0.79 \pm 2.88$ D at three years, $-1.14 \pm 1.96$ D at four years, and $1.07 \pm 1.82$ D at five years (Figure 3).

Mean residual cylinder values decreased after corneal transplant when compared with preoperative values. The mean cylinder value of our patients was $-6.57 \pm 2.15$ D preoperatively and $-4.71 \pm 3.51$ D one month after surgery; $-5.22 \pm 2.68$ D at the third month, $-6.03 \pm 2.09$ D at the sixth month, and $-4.33 \pm 2.19$ D at one year. These values were $-4.61 \pm 1.88$ D at the second year and $-4.60 \pm 2.12$ D at the third year.

They decreased to $-3.64 \pm 1.86$ D in the fourth year, and to $-3.43 \pm 1.74$ D in the fifth year (Figure 4).

COMPLICATIONS

The complications that arose, both intraoperatively and postoperatively, in our series of 34 patients were the following: No significant complication arose during surgery. Postoperatively, the main complications were rejection episodes and side effects of long-term corticoid treatment.

Transplant rejection episodes

Although keratoconus is categorised as low risk for rejection, it is not exempt from this alarming complication. In our study, there was a rejection incidence of 8.82% (3 cases out of the 34 evaluated). Two of such cases recovered with topical and systemic treatment (66.7%) but one patient (33.3%) did not recover, which made retransplantation necessary.

Side effects of topical corticoids

The incidence of the appearance of cataracts due to corticoid administration was 14.70%, which caused
these patients a decrease in their VA and subsequent recovery after phacoemulsification and intraocular lens implantation.

The incidence of ocular hypertension was 11.77%. This increase in the intraocular pressure was controlled in all cases by medical treatment, and no surgery was needed.

No other complications described in the literature, such as Urrets-Zavalia Syndrome, relapse of keratoconus, or endothelial decompensation of the donor corneal lenticule, occurred in our series.

DISCUSSION

Penetrating keratoplasty is a technique indicated for the treatment of keratoconus, especially in advanced stages of the disease. The main indications for penetrating keratoplasty in the treatment of keratoconus are low VA and intolerance to contact lens wear, as observed in our study and in the literature\(^1,2\).

Penetrating keratoplasty is performed on young subjects of a mean age of between 30 and 40 years. The mean was 37.25 years in our series, which coincides with the results described in the literature\(^6,8\).

As published previously, there was also a predominance of the incidence of penetrating keratoplasty in males in our study. The reason for this predominance is not wholly clear. It seems that it may be because either the disease progresses more quickly in men, or that men tend more towards opting for surgery as a therapeutic option\(^1\).

As it is well known, keratoconus is usually a bilateral pathology, consequently, in such cases, keratoplasty should be performed on both eyes sequentially\(^9,12\).

The visual results of penetrating keratoplasty are good in most cases\(^13\). Almost all the subjects in our study experienced an increase in visual acuity after the transplant. In our series, the percentage able to achieve visual acuity of over 0.5 was 67.64% at three years, which is a lower percentage than that described by other authors (between 70 and 91%)\(^14,16\), caused by the existing residual refraction. Another point to be underscored is that visual rehabilitation is slow and most patients require optical correction after the transplant.

Several authors also indicate that the limitations in the final visual acuity are keratitis punctata, transplant rejection, and cataracts, as well as residual refractive defects.

The refractive results show that most patients become myopic after surgery and that the cylindrical area decreases after the transplant. In our series, the
spherical equivalent went from 1.25±2.62 dioptres to -0.79±2.88 dioptres at three years, which is of a less magnitude than reported in the literature.

Nevertheless, although the cylindrical area decreased in comparison with the values prior to surgery, it was greater than what has been described to date (-4.60 ± 2.12 dioptres in our study compared with 2.52 ± 2.45 dioptres)\(^2\). This was because in our hospital no intraoperative or postoperative method was used to monitor and minimise the residual corneal astigmatism\(^17\). In spite of this and although it involves a limitation in the visual rehabilitation, keratoplasty affords an improvement in patients’ vision\(^18,19\).

Corneal transplant is not, however, an innocuous procedure as there is the risk of complications which, although of low incidence, could occur. Among them is transplant rejection, topical corticoid side effects, or a relapse of keratoconus, which would limit the prognosis of the procedure\(^20\). Moreover, it must be remembered that this surgery is performed on young patients who have a prolonged life expectancy and that the transplant must survive for a long time. To avoid rejection, systemic immunosupression was administered to all the patients after surgery for the first two years. Rejection occurred in 8.82% of the cases, however most of these patients recovered with medical treatment. The incidence of cataracts was low. It must be made clear that cataract treatment involves a risk factor for failure of the transplant due to loss of endothelial cells with the risk of endothelial decompensation. Moreover, this surgery causes a loss in the accommodating capacity of the patient, which may be very important because, as mentioned above, surgery is performed on a high percentage of young patients.

To conclude, it must be stressed once again that penetrating keratoplasty is indicated for the treatment of keratoconus in its severe stages\(^3\) as stated above. Above all, the introduction of new techniques (such as intracorneal rings) provide an interesting alternative that are easy to perform and can delay or avoid performing a transplant.

Likewise, lamellar keratoplasty, which is also a treatment for severe keratoconus, has the advantage of preserving the endothelium of the recipient cornea which reduces complications, such as infection or rejection, but it also has disadvantages, such as manual dissection which gives an irregular bed that alters the visual outcome, and risks of perforation.

For all these reasons, penetrating keratoplasty is a technique that is required for this type of pathology, so long as it is restricted to the previously-mentioned indications, because although it is not without risk, the results obtained if the procedure is adequate are highly satisfactory.

REFERENCES