Peer-Reviewed Literature:

Contact Lenses for Irregular Corneas

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Gas-permeable contact lenses are widely used to correct eyes with irregular corneas. These lenses are composed of a rigid polymer that enables them to hold their shape against an irregular corneal surface, thereby creating a tear layer that corrects for optical aberrations such as irregular astigmatism. Although penetrating keratoplasty (PKP) procedures have provided much of the experience needed to fit contact lenses to irregular corneas, the growing number of patients seeking contact lenses after complicated refractive surgery inspires eye care professionals to search for improved techniques and materials. The following articles were reviewed for the analysis of contact lens fitting following PKP and refractive surgery:

1. *Touzeau O, Borderie VM, Allouch C, Laroche L. Late changes in refraction, pachymetry, visual acuity, and corneal topography.* Cornea. *2006;252:146-152.*

2. *Gruenauer-Kloevekorn C, Kloevekorn-Fischer U, Duncker GI. Contact lenses and special back surface design after penetrating keratoplasty.* Br J Ophthalmol. *2005;89:1601-1608.*

3. *Javadi MA, Motlagh BF, Jafarinasab MR, et al. Outcomes of penetrating keratoplasty in keratoconus.* Cornea. *2005;24:941-946.*

4. *Lagnado R, Rubinstein MP, Maharajan S, Dua HS. Management options for the flat corneal graft.* Cont Lens Anterior Eye. *2004;27:27-31.*

5. *Martin R, Rodriguez G. Reverse geometry contact lens fitting after corneal refractive surgery.* J Refract Surg. *2005;21:753-756.*

6. *Rubinstein MP, Sud S. The use of hybrid lenses in management of the irregular cornea.* Cont Lens Anterior Eye. *1999;22;87-90.*

THE PROBLEM

Optical Aberrations

Following refractive surgery, optical aberrations created by altering the corneal shape may result in reduced BCVA. Touzeau et al[1] studied the changes in optical properties from soon to years after sutures were removed in 64 post-PKP patients. Data gathered included visual acuity measurement, refraction at the corneal plane, defocus, astigmatism, and irregular astigmatism. Years (76.8 months ±25.2) after sutures were removed, spherical equivalent refraction was -3.30 ±2.98D, defocus was 4.31 ±2.15D, astigmatism was 4.46 ±1.99D, and irregular astigmatism was 2.52 ±1.54D. There was no change in these optical aberrations over time. There was a small, but statistically significant, improvement in visual acuity with spectacle correction alone, from 20/33 to 20/30. However, the investigators could not correlate the improvement in visual acuity with changes in subjective refraction or topographic surface regularity.

Gruenauer-Kloevekorn et al[2] used Fourier series harmonic analysis with a videokeratoscope to quantify each component of the corneal topography data. In 28 eyes following PKP, 57.2% had spherical power, 96.4% had regular astigmatism, and 100% had irregular astigmatism outside of the normal range.

In a series of 164 eyes following PKP to treat keratoconus, Javadi et al[3] reported a mean spherical error of -0.61 ±2.60D and mean corneal astigmatism of 3.40 ±1.80D at 35.5 months postoperatively. These aberrations resulted in a mean BSCVA of 20/25. However, this study did not address irregular astigmatism.

Studies of BSCVA fail to address the problem of adaptation to high cylindrical spectacle prescriptions. According to Javadi et al,[3] a successful outcome for PKP surgery includes a refractive error that is "tolerably corrected" with spectacles. Although not optimal, spectacles are typically prescribed following surgery.

SOLUTIONS

Spectacles, Surgery, and Contact Lenses

Javadi et al[3] treated all patients with spectacles, suture adjustment, and selective suture removal or relaxing incisions. Suture adjustment was performed with a single running suture in eyes with more than 5.00D of astigmatism 3 to 6 weeks postoperatively. Selective suture removal was performed with interrupted or combined sutures in eyes with more than 6.00D of astigmatism at 2 months and more than 4.00D of astigmatism at 4 months postoperatively. Patients with more

than 5.00D of astigmatism 2 months after their sutures were removed received relaxing-incision surgery.

Many surgeons choose other strategies such as the correction of astigmatism with the use of an excimer laser and the implantation of toric PCIOLs. These procedures are permanent, however, and depend upon stable conditions.[2] Contact lenses offer a solution that is both impermanent and easily adaptable to changing vision and keratometry.

Types of Lenses

Gruenauer-Kloevekorn et al[2] discussed five designs of gas-permeable lenses used to fit irregular corneas after PKP procedures: (1) tricurve; (2) keratoconic; (3) tetracurve reverse (geometry); (4) oblong; and (5) bitoric. Tricurve lenses are the simplest design and have three curvatures that become progressively flatter toward the lens' periphery. Keratoconus-designed lenses fit prolate grafts with high eccentricity and steep base curves. Tetracurve-reverse-geometry–designed lenses fit oblate grafts with negative eccentricity and have peripheral curves that may be changed based on the fit. Reverse-geometry lenses are designed with a second, more peripheral zone that is steeper than the base curve of the lens, as opposed to traditional lenses, which become flatter toward the periphery. In a case series of 11 patients who had flat corneal grafts, Lagnado et al[4] found that all patients required reverse-geometry lenses for a satisfactory fit. As is the case with tetracurve–reverse-geometry lenses, oblate lenses also have a reverse curve for oblate grafts but have an aspheric periphery instead of tetracurve peripheral curves. Last, Gruenauer-Kloevekorn et al[2] used bitoric lenses for high corneal toricity in the donor tissue.

Reverse-geometry gas-permeable contact lenses following myopic corneal refractive surgery were studied by Martin and Rodriguez.[5] They discussed that hydrogel contact lenses are not optimal for postrefractive surgery corneas because the lenses cannot mask corneal irregularities and have been associated with an increased risk of corneal erosions. Likewise, scleral lenses have been used, but they are not widely available.

Rubenstein and Sud[6] retrospectively reported the use of a hybrid contact lens, the Softperm lens (CIBA Vision, Duluth, GA), on patients with keratoconus, irregular astigmatism, and previous PKP. Hybrid contact lenses have a rigid gas-permeable optic zone with a hydrogel peripheral zone. Traditionally fit for keratoconus, the hybrid contact lens is indicated upon the failure of gas-permeable lenses due to poor comfort, excessive mobility, severe apical staining, the lens' decentration, or poor vision.

Success with Gas-Permeable Lenses

In a study by Gruenauer-Kloevekorn et al,[2] all 28 patients who were fitted with various designs of gas-permeable contact lenses had superior visual acuity of at least one line compared to those patients with spectacle correction. Contact lens tolerance was successful in all patients (without any disturbance for at least 6 hours/day). There were no complications during the study's follow-up period.

According to Lagnado et al,[4] four of 11 patients experienced an improvement in visual acuity with reverse-geometry contact lenses fit after PKP. Six patients had selective suture removal and did not require the use of contact lenses to improve their visual acuity from that achieved with spectacle correction. One patient was content with an unaided visual acuity of 20/17.

Martin and Rodriguez[5] documented that, after corneal refractive surgery, reverse-geometry contact lenses yielded an improvement in visual acuity over spectacles of greater than or equal to two lines in five of nine patients, one line in two of nine patients, and no improvement in two of nine patients. No loss of visual acuity with contact lenses was shown. Patients tolerated the lenses for 10.44 ±0.88 hours/day.

It should be noted that the Softperm hybrid lens utilized in the study by Rubenstein and Sud[6] had a different indication for its use as compared with the gas-permeable lenses in the other studies. Rubenstein and Sud used the Softperm to improve the fit, comfort, and wearing time of the lens in comparison to gas-permeable contact lenses. None of the patients in this study were fit solely to improve their visual performance. Success was determined based on the lens' stability, adequate lens movement and comfort, wearing time, a visual acuity of 20/30 or better, and the absence of significant corneal staining. Based on these criteria, seven of 12 patients were determined to be successful, and five of 12 were considered unsuccessful. The reasons for failure included contact lens intolerance, handling difficulties, variable vision, and vision not improved with the Softperm lenses. One patient dropped out of the study.

THE BOTTOM LINE

There is little debate that irregular corneal surfaces created by both PKP and refractive surgery produce optical aberrationst that reduce BCVA. Treatment options include spectacle, surgical, and contact lens correction. All of the studies mentioned herein are in agreement that contact lenses following PKP surgery and corneal refractive surgery are a safe and effective method of vision correction. Gas-permeable contact lens designs are continuing to evolve in order to meet the needs of the complex postsurgical patient. To this end, there are currently new hybrid lenses with higher oxygen-permeability properties awaiting FDA approval for use in postsurgical contact lens fitting. It is hoped that lenses with higher oxygen permeability will serve as a basis for new lens modalities suited to the postsurgical patient. ■

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