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CATARACT SURGERY

Presbyopia-correcting IOLs in Patients with Fuchs Dystrophy: Indications and Contraindications

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Early evidence indicates that the spatial precision scale provides a useful way to determine whether a given Fuchs dystrophy patient will be able to succeed in a presbyopia-correcting IOL.

A commonly encountered corneal condition, Fuchs endothelial dystrophy affects a significant portion of the elderly population. The disease affects women more often and more severely than men. The rising popularity of presbyopia-correcting IOLs (PC-IOLs) makes corneal assessment an increasingly important aspect of the preoperative workup in all cataract surgery candidates. In Fuchs dystrophy patients, the condition of the cornea determines whether or not the candidate is likely to succeed with a PC-IOL—and, if so, what kind of PC-IOL is most appropriate.

There are no clear clinical guidelines regarding evaluation of Fuchs' patients in the setting of PC-IOLs, so each surgeon must use his or her own clinical judgment. The important questions are:

- Which PC-IOL is appropriate for a given level of disease?
- At what level of disease should implantation of a PC-IOL be avoided entirely?

Looking for Guidance

We have attempted to approach this problem systematically, and we present a simple, semi-quantitative method to help answer these questions. A larger and properly designed prospective clinical trial is needed to validate this approach. However, in the absence of such a study, we feel that—in the context of additional information—our method is a useful way for clinicians to get a reading on whether or not implantation of a PC-IOL is indicated in a given Fuchs dystrophy patient.

Our method starts with the assumption that the optical performance of a structure in the visual system depends, in the first approximation, on the spatial precision of that structure. We define the spatial precision of an optical structure as the characteristic spatial precision dimension of that structure that is clinically important for vision.[1] The more accurate and precise an optical structure, the smaller its spatial precision. We have formulated a spatial precision scale to assist in comparing the individual spatial precisions of various ocular elements.[2]

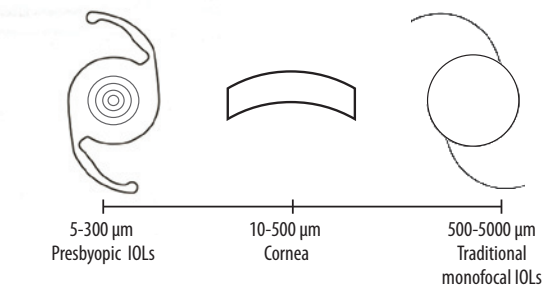

FIGURE 1 The spatial precision scale analysis of a monofocal IOL, cornea, and PC-IOL. Multifocal IOLs are spatially the most precise, followed in turn by cornea and monofocal IOLs.

For example, a monofocal IOL is spatially uniform throughout its entire 5- or 6-mm optic, and, therefore, its spatial precision is on the order of 1 mm. In contrast, modern multifocal IOLs are much more spatially precise, with spatial precision values on the order of 5 to 10 microns (Figure 1).

Spatial Precision Analysis

The steps in a spatial precision analysis are straightforward:

1. Display and rank the spatial precision values of all relevant optical structures.
2. For any given pair of optical structures, the one with the smaller spatial precision dimension (ie, the greater

spatial precision) is dependent upon the optical performance of the structure with the larger spatial precision dimension. The cruder element is the "rate-limiting" factor for any given pair of optical structures. (In our diagrams, the cruder element is on the right.)

In order to use a spatial precision scale to analyze Fuchs' corneal dystrophy, we had to identify spatial dimension parameters that are characteristic of the condition and that change with disease severity. Fuchs dystrophy is characterized by decreased corneal endothelial cell count, which results in corneal edema and increases in both endothelial cell size and morphologic variability. This allowed us to use endothelial cell specular biomicroscopy to assess the severity of the patient's condition. Specific measures included endothelial cell density and coefficient of variation (which denotes the variability of endothelial cell size and morphology), corneal pachymetry, and gutatta size and confluence.[3]

TABLE 1 Case reports of two Fuchs patients who have received PC-IOLs.

Patient	BCVA	Level of satisfaction (10 = very satisfied)	Gutatta size and confluence (microns)	ECD	CV	Pachymetry (µm)	IOL Type
1	20/25	2	10	2200	45	570	Multifocal
2	20/40	7	250	1200	55	680	Accommodating

BCVA = best corrected visual acuity; ECD = endothelial cell density; CV = coefficient of variation

Spatial Precision in Practice

In Table 1 we describe two Fuchs dystrophy patients who were implanted with PC-IOLs. Patient 1 had mild Fuchs' dystrophy, and after implantation of a multifocal IOL was not satisfied with her visual outcome. In contrast, patient 2 had more severe disease but was nonetheless satisfied with the accommodating IOL he received. If we were to predict outcome exclusively on the severity of the patients' disease, we would expect patient 1 to be the more satisfied, but the opposite was true.

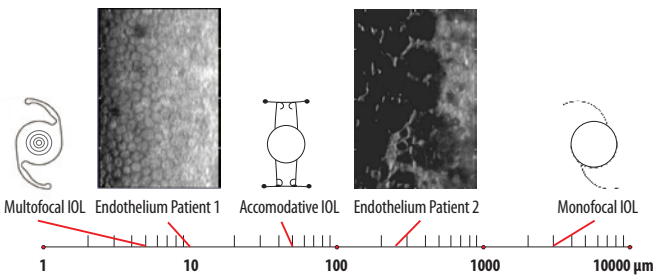

FIGURE 2 Spatial Precision Scale analysis in these two Fuchs patients (specular microscopy photos using Konan Medical, Torrance, CA). The order of spatial precision is (from most precise to least): multifocal IOL, Fuchs patient 1, accommodating IOL, Fuchs patient 2, and monofocal IOL.

We can use spatial precision analysis to explain this clinical observation. Although pachymetry, endothelial cell density, and coefficient of variation are needed to characterize Fuchs dystrophy fully, we chose to take gutatta size as a starting point, since it gives us a simple spatial dimension that is both relevant to Fuchs dystrophy and lends itself readily to spatial precision analysis—indeed we use gutatta size as a measure of the spatial precision of the patient's cornea. This is shown in Figure 2.

In that figure, the spatial precision of multifocal, accommodating, and monofocal IOLs is shown in parallel with the spatial precision of the corneas of our two Fuchs dystrophy patients. The spatial precision of the multifocal IOL is greater (ie, a smaller value) than that of either patient, suggesting that their corneal disease will be the limiting factor for vision. This predicts the failure of a multifocal IOL if it were to be implanted in either of them.

In contrast, the spatial precision of an accommodating IOL lies between that of these two Fuchs patients' corneas, suggesting that while an accommodating IOL may be contraindicated in the patient with the more severe disease, it is an acceptable choice for the patient with a milder condition.

Our patients' subjective evaluation of their quality of vision after surgery suggests that even the more severely affected patient (patient 2) could succeed with an accommodating IOL. In contrast, the multifocal IOL did not work well even in the patient with considerably milder Fuchs dystrophy. This clinical observation supports our spatial precision analysis, which also suggests that a monofocal IOL—which has a lower spatial precision than either patient's cornea—would perform well for either patient. Larger studies are needed to validate this method.

THE BOTTOM LINE

Fuchs dystrophy is a clinically significant corneal condition in patients of cataract age. With the growth of PC-IOLs, deciding whether or not a Fuchs patient is a good candidate for a PC-IOL has become increasingly important. To this end, we created the semi-quantitative "spatial precision scale" as a means to assess Fuchs dystrophy patients' candidacy for PC-IOL implantation. Early indications are that the spatial precision scale may be useful in determining whether a PC-IOL will provide acceptable quality of vision in Fuchs dystrophy patients. Further studies are needed to confirm these findings and to establish a more robust spatial precision scale for clinical application.

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