ANTERIOR CHAMBER INTRAOCULAR LENS

BACKGROUND OF THE INVENTION

This invention relates to intraocular lenses for implantation in the anterior chamber of a human eye and more particularly to an intraocular lens having position fixation elements whose effective size is variable so as to permit use of a lens of one size in human eyes of varying size.

The implantation of an intraocular lens is a well known and widely used technique for restoring vision after cataract surgery. The natural structure of the eye furnishes a variety of locations for fixing the position of an intraocular lens in the eye. For example, an intraocular lens can be supported anteriorly of the iris, between the scleral spur and the iris, as disclosed in my U.S. Pat. Nos. 4,174,543 and 4,092,743. Alternatively, an intraocular lens can be supported posteriorly of the iris as disclosed, for example, in U.S. Pat. No. 4,159,546 to Shearing. In practice, anterior chamber lenses are the easiest to implant because the anterior chamber angle can be viewed by the surgeon while he seats the position fixation members therein. This, of course, is not the case with posterior chamber lenses, since they seat behind the iris.

Lens implantations are not only extremely difficult and delicate operations but the use of the currently available anterior chamber lenses, even by highly skilled surgeons, entails a number of disadvantages. One of these is that due to the different sizes of the eyes of different patients a sizable inventory of lenses is currently required by the surgeon to be immediately available in the operating room during the operation. Since the internal diameter of the anterior chamber angle, that is the diameter of the groove formed between the iris and the scleral spur, varies from patient to patient, (generally within a range of 11.5 thru 14.0) millimeters, the lenses currently available are manufactured in half-millimeter increments within that range which is the normal size range for human eyes. Thus lenses are currently available with diameters of 11.5, 12.0, 12.5, 13.0, 13.5 and 14.0 millimeters. Many of these lenses are furthermore available in powers varying from 14.50 thru 22.00 diopters in one diopter increments at the low and high end of the scale and in half diopter increments in the mid-range of that scale. It is very difficult with existing instrumentation to precisely measure the diameter of the anterior chamber angle in which the anterior chamber lens will be seated, prior to the time when the patient is actually in the operating room and an incision has been made. Thus, for each half-diopter increment in the aforesaid mid-range, the surgeon must have available in the operating room seven lenses of different size. It is only after the incision has been made that the most accurate known method for measuring the anterior chamber angle diameter, namely the dip-stick method, can be used.

Once the internal diameter of the anterior chamber has been measured accurately, the surgeon chooses from his inventory of differently dimensioned lenses that lens which most nearly approximates the measured dimension.

Anterior chamber intraocular lenses are known which exhibit some degree of flexibility. Usually the flexibility is for the purpose of compensating for tolerance error in the dimension of the lens, for measurement error on the part of the surgeon, for permitting some flexure in response to normal deformation of the eyeball, or, since lenses commonly are manufactured in half millimeter sizes, for allowing for differences between actual lens size and anterior chamber angle diameter should the angle or groove diameter fall somewhere between two discrete lens sizes. For example, my U.S. Pat. No. 4,092,743 describes an anterior chamber intraocular lens in which the three-point position fixation element is sufficiently flexible to compensate for small differences, up to about one-half millimeter, between the diameter of the groove in the eye in which the lens is to be implanted and the size of the lens in its undeformed condition. Also, my U.S. Pat. No. 4,147,543 discloses a four-point anterior chamber lens which can be deflected along lines drawn diagonally through its four contact points. Such deflection is stated to be in response to the "normal distortions of the eyeball."

Since the latter lenses are intended to deflect only to the extent required to compensate for normal distortions of the eyeball so as to minimize the distortion-related trauma sometimes attributable to an intraocular lens implant, a lens of proper size i.e. one which has a dimension approximating as closely as possible the measured groove dimension must be used to achieve good results. Since the lenses come in discrete sizes and since it is extremely unlikely that the diameter of the anterior chamber angle in the eye will match exactly one of those discrete sizes, the optimum lens fit is hardly ever achieved with known anterior chamber lenses.

The known anterior chamber lenses which have flexure capability, have such capability for an entirely different purpose and to a substantially different degree than is the case with the lens according to the instant invention. None of the known anterior chamber lenses, are capable of minimizing the lens inventory in the operating room to the extent of the instant invention which provides for a single anterior chamber lens adapted to fit all eyes within the normal size range.

Posterior chamber intraocular lenses, on the other hand, have for some time now been made flexible enough to fit all normal posterior chambers. Since, however, posterior chamber lenses, particularly when implanted after extra capsular cataract removal, can be seated in the capsule i.e., in a membrane which is relatively inert in that it has no nerve endings and no blood vessels, and which can therefore readily withstand punishment imposed by seating therein of springy position fixation elements, the forces exerted by, and the length of the contact areas of, the latter, are not nearly as critical in the posterior chamber capsule as in the anterior chamber. In this connection it should also be remembered that surrounding the anterior chamber angle in the vicinity of the scleral spur is the trabecular meshwork which normally pumps fluid out of the eye into Schlemms' canal, which canal, in turn, peripherially surrounds the trabecular meshwork. Any undue pressure on the anterior chamber angle in the vicinity of the scleral spur, such as may be caused by a lens implant, may interfere with the proper functioning of Schlemms' canal and may cause pain and inflammation.

While some slight interference with the functioning of the canal does not appear to be detrimental, more substantial interference as would be occasioned by anterior chamber lenses having seating portions extending over substantial peripheral regions of the anterior chamber angle and thus sealing substantial portions of the trabecular meshwork and possibly even transmitting